How Norms Are Maintained and How They Change:

A Mathematical Model and a Field Study

by

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ABSTRACT

Social norms are unwritten behavioral codes. They direct individual behaviors, facilitate interpersonal coordination and cooperation, and lead to variation among human populations. Understanding how norms are maintained and how they change is critical for understanding human evolutionary psychology, social organization, and cultural change. This dissertation uses a mathematical model and a field study to answer two questions: First, what factors determine the content and dynamics of a social norm? Second, how do people make decisions in a normative context? The mathematical model finds that contrary to the popular belief that even arbitrary or deleterious social norms can be maintained once established because deviants suffer coordination failures and social sanctions, norms with continuously varying options cannot be maintained by the pressure to do what others do. Instead, continuous norms evolve to the optimum determined by environmental pressure, individual preferences, or cognitive processes. Therefore, the content of norms across human societies may be less historically constrained than previously assumed. The field study shows that unlike what rational choice theory predicts, people in a small-scale subsistence society do not calculate the ecological and social payoffs of different behaviors in a normative context, even when they have the information to do so. Instead, they rely heavily on social information about what others do. This decision-making algorithm, together with mental categorization that ignores small deviations, and cognitive biases that favor the division prescribed by the norm, maintain an ecologically inefficient and widely disliked cooperative surplus division norm in a Derung village, Dizhengdang, in Yunnan, China.

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Chapter 1

GENERAL INTRODUCTION

Social norms are cultural rules that prescribe the social consequences of behaviors. They govern individual decisions (see Berkowitz 2005; Deutsch and Gerard 1955; Haines and Spear 1996; Truman 1884, for some examples), impact group outcomes (e.g., Gelfand et al. 2021) and have shaped the psychology and evolutionary history of our lineage (Boyd and Richerson 2009; Jones 2016; Henrich 2004; Richerson et al. 2016). Understanding how norms evolve in response to environmental pressure or intergroup contacts is important for explaining observed norm patterns, for interpreting the role of norms in human evolution, and for designing social programs to maintain certain norms and change others. In this dissertation, I identify the factors that impact whether and how a norm changes under new ecological, economic and social conditions. The factors considered include cognitive processes, psychological tendencies, and individual decision-making.

I define social norms as practices common in a cultural group that 1) are acquired socially, 2) correspond to expectations about what others do or think, and 3) for which deviants receive lower payoffs than the common type. This definition excludes "norms" that are wide-spread personal routines not subject to social observation and evaluation, like brushing teeth. In this dissertation, the term "norm" always refers to social norms with positive-frequency-dependent payoffs. This definition does not require a norm to be accompanied by other people's moral evaluations or conscious reactions, although in human societies, even conventions and coordination solutions

are often accompanied with moral judgments— if you drive on the wrong side of the road, you are not only "stupid" but also "irresponsible".

Chapter 2

"DOING WHAT OTHERS DO" DOES NOT STABILIZE CONTINUOUS NORMS

Theoretical Background

One defining property of social norms is that they are subject to positive frequency dependent selection (Bicchieri 2016; Brennan et al. 2013; Schelling 1978; H. Peyton Young 2011). The behaviors of other group members disadvantage individuals who deviate from the common practice. Possible mechanisms include coordination failure, reputation loss, withdrawal of help, second-party punishment, third-party punishment, reputation-based social learning, and conformity-biased social learning. Therefore, as the frequency of members adopting a given norm variant increases, the payoff of that variant increases, and the payoff of other variants decreases. To capture norms' property of rewarding similarity between interactants, much previous work represents norm interactions as coordination games. Most (Akerlof 1980; Centola, Willer, and Macy 2005; DellaPosta, Nee, and Opper 2017; Kuran 1995; Lustick and Miodownik 2019; H Peyton Young 1998, 2011) consider a few discrete choices and find that such similarity-based payoffs can stabilize different norms in otherwise identical settings, and that shifts between norms follow a tipping process. For example, Young (H Peyton Young 1998, 2011) models norm evolution using a two-person game of pure coordination. Individuals are paired at random and receive the payoffs given in Table 1. They assess the distribution of behaviors in the population based on past interactions. They usually adopt the strategy that maximizes their payoff, but occasionally adopt a lower payoff strategy by mistake or through experimentation. A population in which norm A is common has a higher average payoff than one in which

norm B is common, but once B is common, it can persist at high frequency because rare individuals with norm A are likely to be paired with an individual using norm B and receive a lower payoff than B individuals interacting with other B individuals. Shifts happen only when mistakes or experimentation cause the rare norm to increase enough that a tipping point is reached, and convergence to the new norm happens quickly thereafter. Incorporating third party punishment (Centola, Willer, and Macy 2005; DellaPosta, Nee, and Opper 2017), deliberate deviation by activists (Kuran 1995; Lustick and Miodownik 2019), or population structure (Centola, Willer, and Macy 2005; DellaPosta, Nee, and Opper 2017; H Peyton Young 1998, 2011; Lustick and Miodownik 2019; Kuran 1995) produces similar dynamics, although some population structures, like local interactive networks (Centola, Willer, and Macy 2005; DellaPosta, Nee, and Opper 2017; H Peyton Young 1998, 2011) or heterogeneity in individual switch thresholds (Lustick and Miodownik 2019; Kuran 1995) can amplify the effect of random events or reduce the basin of attraction of the original norm, and thus make shifts more likely.

Table 1. Payoff Matrix for Discrete Coordination Game

	norm A	norm B
norm A	2	0
norm B	0	1

There are, however, many norms that are not categorical but instead vary continuously. Examples include tipping percentages (Azar 2004), phonological norms (e.g how to pronounce the "a" in "tomato"), interactional norms (e.g., how far to stand from the person one is chatting with) (Hall 1989), and word meanings (e.g. what "silly" refers to) (McWhorter 2016). Evidence suggests these norms tend to change

constantly (Azar 2004; McWhorter 2016). There are two models that consider norms with a continuous range of variants (Azar 2004; Kuran and Sandholm 2008). Both report that a continuous norm keeps evolving until it reaches a single equilibrium (but see proposition 3 (iii) in (Azar 2004)). There are also models of the evolution of color terms in laboratory experiments that incorporate continuously varying category boundaries. These boundaries are norm-like in that there are similarity-based payoffs (Kallens, Dale, and Smaldino 2018).

In this paper, we place continuous and discrete norms in a single framework and identify the key factors that determine whether a norm evolves like a discrete one or a continuous one. We start by analyzing a model of continuous norm evolution that incorporates the same qualitative assumptions about similarity-based payoffs as the discrete models described above. In the base model, individual payoffs are similarity-based and an individual's payoff is higher if their behavior is closer to the mean behavior in the population. We also consider extensions in which the trait that receives the highest normative payoff is correlated with but not exactly the average behavior. We show that the dynamics of this model are qualitatively different from that of discrete models: similarity-based payoffs do not lead to multiple stable equilibria. Instead the evolution of a continuous norm is driven by any other selective or demographic process that affects the population, no matter how weak. Selective processes can arise from frequency-independent direct payoffs set by the environment, moral beliefs, or cognitive attractors. We then show that cognitive attractors or the categorization of continuous phenomena can cause norms applying to continuously varying behaviors to evolve as if they were discrete.

Given that many norms can be viewed as having continuous choices, this work modifies our understanding of norms and their role in human social evolution in two

ways. First, some norms that apply to continuous behavioral spaces nonetheless may evolve as if they were discrete due to the effects of cognitive attractors or categorization. Second, some norms may be less arbitrary or path-dependent than we thought but instead capable of adapting to the environment, the social structure, or individual psychology. This means that the persistence of between-group differences in behavior, a key feature of human social organization, sometimes results from social or moral preferences or depends on the discretization of a continuous space resulting from cognitive attractors or categorization. This finding also weakens the view that norms by themselves can support the evolution of cooperation. Rather, our findings suggest under some circumstances, evolved prosocial and moral preferences might be necessary to stabilize between-group variation in norms. Lastly, when norms are continuous, norm change may not be a tipping process, but instead take place gradually as individuals change their behavior based on changes in the environment.

Similarity-based Payoffs Do not Affect the Equilibrium Mean of a Continuous Norm

Discrete norms can persist once common despite being undesirable or Pareto-inefficient. Here we show that a continuous norm evolves to the optimum determined by direct individual or group effects or moral preferences.

Base model

Individuals belong to a large population. Member i has a norm value x_i that can take on any real value. At time t the distribution of norm values in the population is normal with mean μ_t and variance V_t. Individuals interact in pairs sampled at random from the population. Payoffs result from two sources. First, the payoffs from

similarity-based normative effects are higher for pairs with more similar norms. Think about how much to tip the waitstaff in the US, where the diner pays a voluntary but socially expected proportion of the restaurant bill. If you are with a friend who tips 18%, she may judge you petty if you tip less and prodigal if you tip more, but appropriate if you also tip 18%. Second, norms may directly affect individual payoffs independently of the normative pressure to do what others do ("similarity-independent direct effects"). If you tip less, you leave with more money. We model these effects by assuming that an individual i with norm value x_i interacts with a second individual with norm value x_j and achieves a payoff $W(x_i|x_j)$, where

$$\ln W(x_i|x_j) = -\frac{(x_i - x_j)^2}{2S} - \frac{(x_i - \theta)^2}{2D} \tag{2.1}$$

The first term gives the payoff from individual i's norm-similarity-based interaction with j. It peaks when x_i and x_j are equal and reflects the normative pressure to do what others do. This payoff expression has the same qualitative structure as the discrete coordination game described above. Since j is randomly selected, individual i receives the highest expected normative payoff if she adopts μ_t, the mean population norm value (See *Appendix A.1* and *Appendix A.2* for a mathematical justification). The second term gives the similarity-independent direct effects of i's behavior on her individual payoff. "Direct" here means it impacts payoffs independent of normative pressure for similarity. (See Table 2 for possible forms of similarity-based norm effects and similarity-independent direct effects.) The relative strengths of similarity-based norm effects and similarity-independent direct effects are given by the parameters S and D. Larger values indicate weaker effects. $W(x_i)$ is thus the product of two Gaussians, one reaching the maximum at $x_i = \mu_t$, and a second at $x_i = \theta$.

After the current generation receives their payoffs, naive individuals from the next generation choose a member from the current generation to imitate with a probability

proportional to that individual's payoff, and acquire the norm value of that individual plus an error that is normally distributed with mean 0 and variance E. In this paper, we use social learning from the previous generation to implement how payoffs update the population distribution, but other mechanisms, for example, social learning from peers or individual strategy updating based on past interactions, give the same qualitative results.

The distribution of norm values after social learning is normal with mean μ_{t+1} (see *Appendix B*)

$$\mu_{t+1} = \mu_t + \frac{(SV_t + V_t^2)(\theta - \mu_t)}{SV_t + V_t^2 + DS + 2DV_t} \tag{2.2}$$

and variance V_{t+1}.

$$V_{t+1} = \frac{DS + DV_t}{SV_t + V_t^2 + DS + 2DV_t} V_t + E \tag{2.3}$$

The variance evolves to a unique stable equilibrium (see *Appendix B.2*), that is unaffected by changes in the mean. The mean norm changes from t to $t + 1$ as a consequence of payoff biased imitation. There is a unique stable equilibrium for the population mean as long as there are similarity-independent direct effects ($D < +\infty$). The equilibrium mean, $\hat{\mu}$, is equal to θ, the value that maximizes similarity-independent direct effects. It does not depend on the initial distribution of norms, or the strength of similarity-based norm effects. However, the equilibrium variance depends on the strength of similarity-based norm effects, and so does the rate at which the mean norm approaches its equilibrium. The stronger the similarity-based norm effects, the longer it takes for the population distribution to reach the equilibrium. If there are no similarity-independent direct effects of norm values on the payoff ($D = +\infty$), the variance reaches a stable equilibrium value, but any value of the mean can be neutrally stable.

Table 2. Possible Forms of Similarity-Based Norm Effects and Similarity-Independent Direct Effects

Evolutionary force	Possible forms (not exhaustive)
Similarity-based normative effects	Pure coordination, e.g., language usage
	Indirect reciprocity based on norm-compliance reputation
	Second or third party punishment of deviant behaviors
	Conformity-biased social learning
	Internalization of status quo as preference
Similarity-independent direct effects on individual	Individual ecological or economic payoff, e.g., food retained after sharing
	Self-interested preference, e.g., money maximization, pro-natal preferences
	Innate psychological tendency, e.g., incest aversion, risk aversion
	Moral preference for a fixed outcome, e.g., inequity aversion, "tit-for-tat", "do no harm"
	Single cognitive attractor or evolved prior, e.g., equal division, ownership to first claimant
	Single stable cultural attractor

Extensions

The simple model above shows that a continuous norm evolves to a unique equilibrium that is unaffected by the social pressure to do what others do. Here we discuss five extensions of the base model that support the same conclusion. The calculations of the similarity-based normative payoffs and the group payoffs are given in *Appendix A*. The calculations of the per-generation evolution and the equilibrium are given in *Appendix B*. Tables S1–S3 summarize the parameters used in the model and the results.

Assortative Interaction

In the base model, individuals interact at random. However, people often prefer to interact with partners whose norms are similar to their own. To model such assortative interaction, we assume that pairs of x_i and x_j are formed from the population with assortment coefficient r, such that given x_j is the focal individual x_i's partner, the expected value of x_j is $rx_i + (1 - r)\mu$. As in the base model, the mean value of the norm evolves to the individual optimum.

Larger Social Groups

In many situations, norms regulate the behavior of more than a pair of individuals. For example, foragers often share food within a band of about 20 people, and an individual's normative payoff depends on her norm matching the norms of other band members. To model this we assume that people interact in groups of size n and the normative component of a focal individual's payoff is a Gaussian function of the difference between her trait value and the average of the trait values of the other $n - 1$ individuals (*Appendix A.4*). Similarity-based norm effects are stronger in larger groups so the per-generation change is smaller, but the equilibrium mean norm is still the individual optimum (*Appendix B.3*).

Learning from more than one individual

People often learn culturally from more than one person. To model this assume that each naive individual selects k social learning models. The probability a person from the previous time period is selected as one of the models is proportional to their payoff. The naive individual then acquires the mean norm value among these models with some error. This reduces the equilibrium variance by a factor of $1/k$, all other

things being equal, but does not change the equilibrium mean norm. (More details in *Appendix B.*)

Optimum norm differs for individual and group

In many circumstances the norm value that maximizes individual direct payoff is different than the norm that is best for the group. In the case of food sharing, it is in each individual's selfish interests to share less, but the group benefits if everyone shares more. Here in addition to similarity-based normative effects and similarity-independent direct effects on individual, we include similarity-independent direct effects that depend on the average norm in the group. An individual joins a social group of size n formed with a constant assortment coefficient r between any pair of members. The value of r varies from 0 to 1, with 0 indicating random group formation. Her payoff contains three terms: 1) normative effects based on the difference between her norm trait and the average norm of the other $n-1$ members; 2) individual direct effects based on the difference between her norm trait and the individual optimum; and 3) group direct effects based on the difference between the group's average norm and the group optimum. With random group formation, the focal individual's norm trait constitutes a fraction $\frac{1}{n}$ of the group average norm; with assortment, her norm trait impacts the group average norm more through the norm traits of the other group members (*Appendix A.5*). The optimum in direct effects thus lies between the individual optimum and the group optimum, and stronger assortment moves it toward the group optimum (*Appendix B.3*). The equilibrium norm is this balanced optimum. Depending on the sequence of the three effects, the strength of similarity-based normative pressure may indirectly impact the equilibrium by influencing the compromise between individual and group optima, but the pressure to do what others

do cannot maintain the original norm or make the new equilibrium norm dependent on the original norm.

Preferred deviation from common behaviors

So far we have assumed that individuals' normative judgements coincide with their own behaviors. Consequently, the value that maximizes the payoff in similarity-based norm effects is the mean norm in the population. Empirically, there may be moral beliefs that specify the best thing to do above and beyond the common behavior. The tipping norm may involve a moral preference for generosity in addition to following the custom. If a friend tips 16% herself, she may think the most of you if you tip 18%. If the custom is to tip 18%, however, a person who does exactly this ceases standing out, and will have to shift to, say, 20%, to achieve the same benefits. To model this situation we assume that the payoff function is:

$$\ln W(x_i|x_j) = -\frac{[x_i - (x_j + \delta)]^2}{2S} - \frac{(x_i - \theta)^2}{2D}$$

In this case, an individual receives the highest expected normative payoff when she adopts $\mu_t + \delta$ (*Appendix A.6*). Therefore, the parameter δ gives the optimal deviance from the common behavior. Assuming the same life cycle as in the base model, the mean norm value in the population evolves to a unique equilibrium value $\hat{\mu} = \theta + \frac{D}{V+S}\delta$ (*Appendix B.3*), which reflects a compromise between the individual optimum, θ, and the social pressure to deviate δ from the average. If people prefer individuals whose traits are more than the average ($\delta > 0$), the equilibrium mean norm value is larger than the individual optimum in direct effects. A moral preference for generosity can thus maintain a tipping norm although the economic optimum is to not tip. As another example, people may benefit from using a strong word in a mild context because it engages the audience, and this can explain the weakening of word meanings

over time. Social pressure matters when it values more than mere similarity, but it does not lead to multiple equilibria as in discrete models.

Similarity-based payoffs do not maintain variation among subpopulations in a structured population

In discrete models, similarity-based payoffs can maintain differences in norms among subpopulations in a structured population, and this fact plays an important role in models of cultural group selection (e.g., Boyd and Richerson 2002). Here we use simulations to show that this does not occur in the present model of continuous norms.

At the start of each time period, a focal subpopulation receives migrants drawn randomly from a source population in which norm values have a normal distribution with constant mean z and variance U. The source population is large and so is not affected by migration from the focal population. After migration, a proportion of $m \geq 0$ of the focal population are the newly arrived migrants. Migrants do not update their norm values. Then members of the focal population, including the migrants, are randomly paired and interact socially. An individual's payoff in similarity-based norm effects decreases as the difference between their norm value and their partner's norm value increases, as in the base model. Assuming m is small, most migrants will interact socially with the original local residents, and if the mean norm value among migrants is significantly different from those among residents, they will achieve lower payoffs than residents. We present the dynamics of continuous norm evolution with migration alone here (i.e., there is no similarity-independent direct effects).

Immediately after migration, the distribution of norm values in the focal population is the weighted sum of the focal population's distribution before migration and the source population's distribution, and so is not normal. If the mean norm values of the

source and focal population are sufficiently different, it will be bimodal. Accordingly, we determine the effect of migration by numerically iterating the distribution of norm values in the focal population. In the simulations, we divide a sufficiently wide behavioral space around the focal population's initial mean norm into sufficiently narrow bins, such that both the residents and the migrants are comfortably covered, and the frequencies of the bins reliably approximate the distribution of the continuous norm traits. After normative interactions, there is payoff biased social learning as in the base model. The social learning error is approximated with the same bins.

Both migration and payoff-biased social learning change the distribution of norm values in the population (Fig. 1A). One might think that similarity-based payoffs could disadvantage migrants, and so maintain the mean norm in the focal population at a different value from the norm in the source population. However, this is not the case. The mean norm value in the focal population always converges to that in the source population (Fig. 1B). This holds true regardless of the coefficient of similarity-based norm effects S, the migration rate m, or the mean norm z or variance U in the source population. The values of m, S, z and U only determine how fast the focal population converges to z.

Discrimination against migrants does not maintain a continuous norm

One might think that the focal population's norm only converges to that of the source population because migration changes the current generation's mean norm, and thus the optimum in normative effects. In this section we set the normative payoff of a trait to be the expected payoff from interactions with only the original residents. This means the migrants have no social capital and interactions with them do not bear any consequences. This reduces the impact of migrants, but the focal population

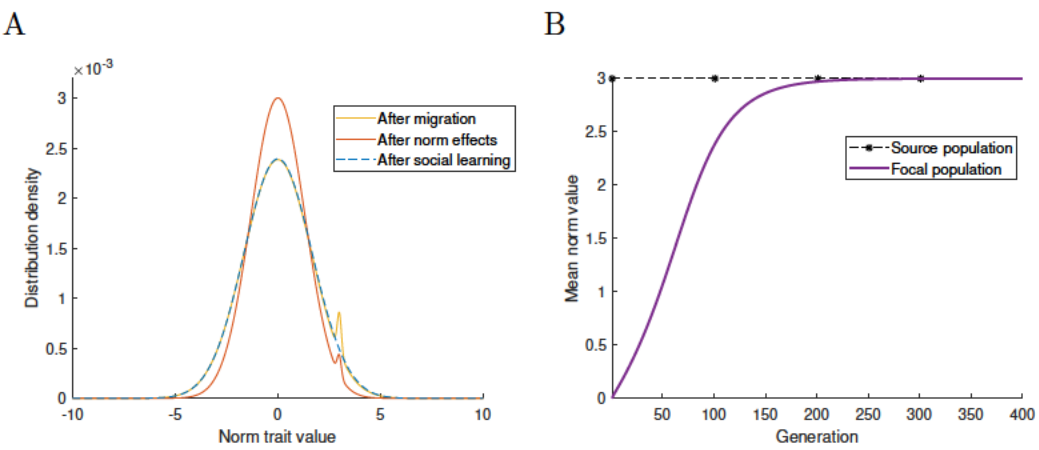


Figure 1. Norm Evolution with Constant Migration

The continuous norm in the focal population converges to that of the source population under similarity-based payoffs. (A): The focal population's norm trait distribution in generation 2 (the first generation with migration) after migration, after similarity-based norm effects, and after social learning with error. Migration shifts the population toward the source population's norm, while norm effects pull it back, but not all the way to before migration. (B): The evolution trajectory of the focal population's mean norm value. The focal population's mean norm changes every generation until it reaches the source population's mean norm. Parameter values: migration rate m=0.01, source population norm z=3, source population variance U=0.1, social effect coefficient S=2, social learning error magnitude E=1. The focal population's initial trait values follow a normal distribution with mean 0 and variance 2.73, which is the equilibrium distribution when the population experiences only similarity-based norm effects with S=2 and social learning with E=1, but not migration.

still evolves to the norm of the source population, because although migrants receive low payoffs in similarity-based norm effects, their payoffs are not 0. Therefore, they may still be selected as social learning models and impact the norm in the next generation. The focal population only maintains its original norm if members of the next generation never socially learn from migrants.

One-sided similarity-based payoffs can maintain a continuous norm

So far, we have assumed individuals with norms greater than or less than the population mean are equally penalized. Sometimes because of moral preferences or a desire to preserve group identity, only deviations on one side of the mean are penalized, while deviations to the other side receive the same normative payoff as those who match exactly with their partner's norm value. In the example of tipping, this corresponds to the scenario that a person who tips 18% judges her partner more and more negatively as their tip becomes lower and lower than 18%, but is content if their partner tips 18% or more, without caring about whether it is 18% or 30%. We operationalize one-sided similarity-based payoffs in the simulations by assigning to the bigger trait in the pair of x_i and x_j the maximum normative payoff of 1, and assigning to the smaller trait the payoff $\exp\big[-\frac{(x_i-x_j)^2}{2S}\big]$, same as in the base model. We find that one-sided similarity-based payoffs cause the mean norm value to increase or decrease indefinitely when there is no other force or when the only other force is migration at low rate. When there are direct effects or strong demographic processes, one-sided similarity-based norm effects allow the focal population to maintain an equilibrium norm that is different from the optimum in direct effects or the migrant norm. However, similar to preferred deviation, the equilibrium under one-sided similarity-based norm effects is not path dependent, and what maintains the continuous norm against direct effects or migration are the social evaluations that make the normative payoffs one-sided, not the pressure to be similar to others.

Discretized Similarity-based Norm Effects Can Maintain Norm Variation

Many continuous variants are grouped into discrete categories in evaluation. Percentage performance is transformed into a letter grade on transcripts. The natural light

spectrum is continuous but colors are described with a finite set of words. In this section, we investigate whether categorization of the continuous norm space can allow similarity-based payoffs to maintain multiple norm equilibria. We present the findings with migration as the external force, but the same result applies to continuous norm evolution with direct effects.

Compared to the base model, we divide the behavioral space into categories of width c. We assume that category boundaries are constant. If norm values in [-1, 1] are discretized as one category, this stays true regardless of the current norm distribution. All norm values in a category are treated as the value at the category center in similarity-based norm effects. As in the base model, individuals interact in pairs, but now their norm payoffs depend not on the difference between their trait values, but on the difference between the center values of their categories. Consequently, all the traits in the same category receive the same payoff in similarity-based norm effects (Fig. 2A). We find that with transmission of either the continuous trait value (Fig. 2B) or the category membership (Fig. 3), similarity-based payoffs can preserve norm heterogeneity if the categories are broad enough.

Why can discretized norm effects maintain a continuous norm? Categorization can allow the maintenance of the equilibrium norm close to its initial value because external forces change the distribution of the categories less than they change the distribution of the underlying continuous traits, so similarity-based norm effects on the categories are better able to bring the mean norm back to the value before external forces than social effects on the continuous traits. Consequently, if the category boundaries evolve with the population distribution, or if the category boundaries are constant but individuals are treated as having the weighted average value instead of

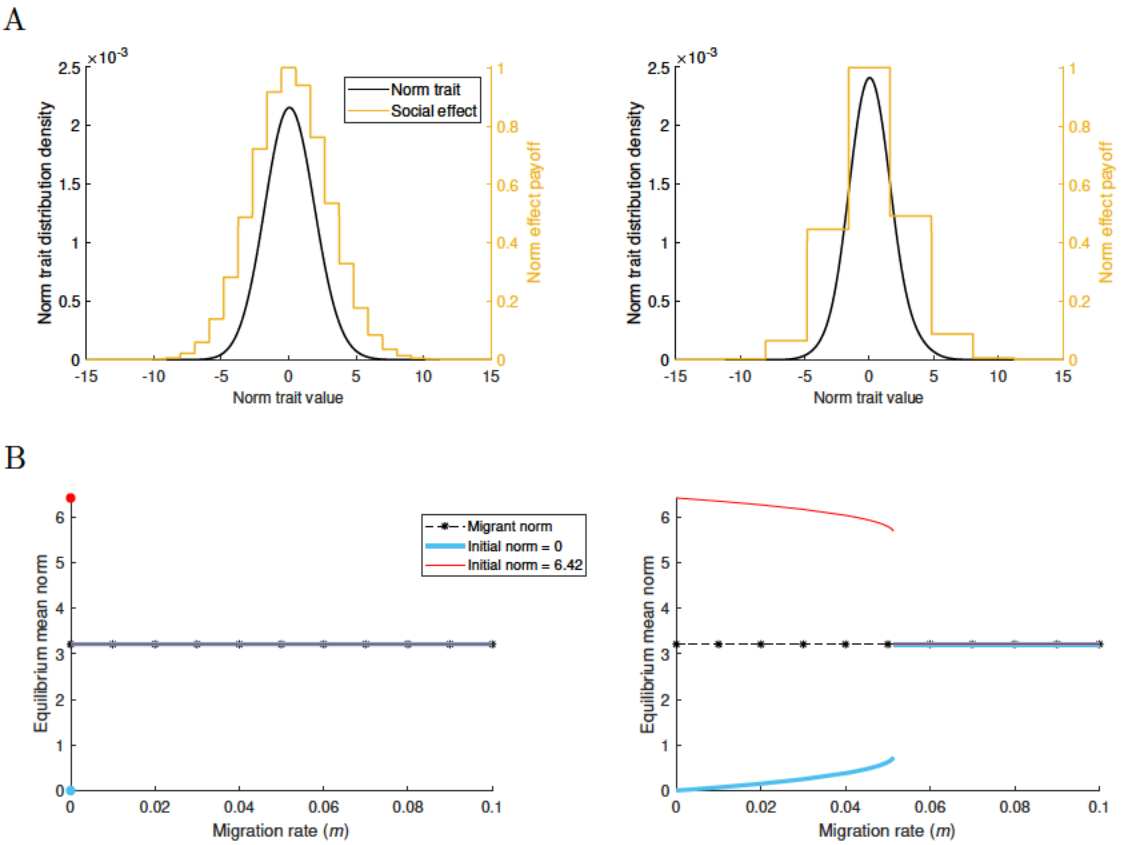


Figure 2. Discretization's Effects on Similarity-Based Payoffs and Norm Equilibria, When Social Learning Is of the Continuous Norm Value

Left panels have category width 1.07. Right panels have category width 3.21. When categories are wide, populations with different initial norms can maintain their differences despite migration. (A): Norm trait distribution (black) and norm payoff (orange) in the focal population. With discretization, adjacent norm trait values receive the same payoff in norm effects if they are in the same category. Thus the norm payoff function is also discretized. (B): Equilibrium mean norm as a function of the migration rate. When categories are narrow (left), the focal population's mean norm converges to the source population's mean norm even at low migration rates; When categories are wide (right), the equilibrium mean norm in focal population remains close to the initial norm when rates of migration are low. Parameter values: source population mean norm z=3.21, source population trait variance U=3.24, coefficient of similarity-based norm effects S=4, social learning error magnitude E=1. The focal population's initial mean norm before migration starts is 0 or 6.42. The initial trait distribution is not normal because of discretized norm effects. Its variance is 3.28 for category width 1.07 and 2.79 for category width 3.21.

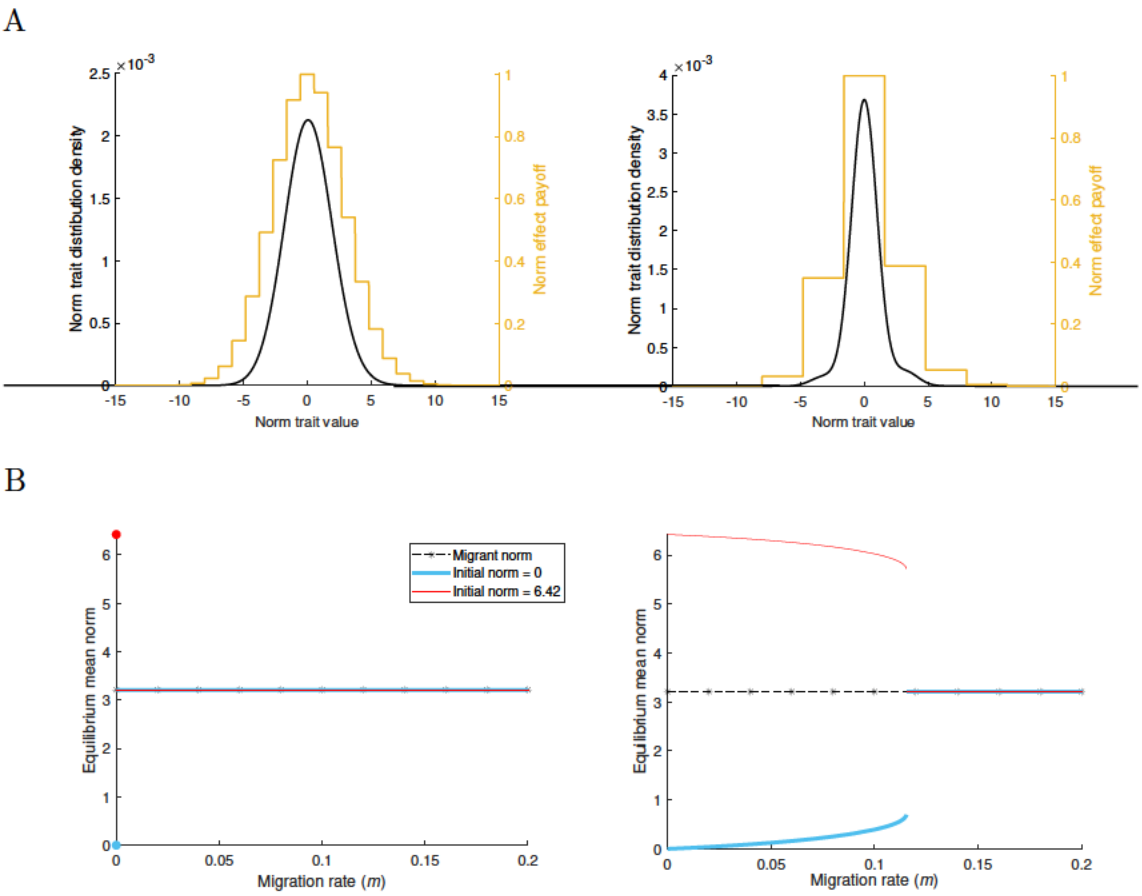


Figure 3. Discretization's Effects on Similarity-Based Payoffs and Norm Equilibria, When Social Learning Is of the Category

Left panels have category width 1.07. Right panels have category width 3.21. Compared to Fig. 2, social learning of the category does not change the effects of discretization. Parameter values: source population mean norm z=3.21, source population trait variance U=3.24, coefficient of similarity-based norm effects S=4, social learning error magnitude E=1. The focal population's initial mean norm before migration starts is 0 or 6.42. The initial trait distribution is not normal because of discretized norm effects. Its variance is 3.36 for category width 1.07 and 1.64 for category width 3.21.

the center value of their category, the effect of discretization disappears, and group differences can no longer be maintained.

Fig. 4 shows how category widths determine the focal population's new equilibrium mean norm by impacting the magnitude of mean norm change from discretized norm effects. Migration pulls the mean norm in the focal population toward the source population norm, but norm effects pushes the mean norm in the opposite direction. The mean norm value change due to discretized norm effects in a given generation, calculated as the mean norm value after norm effects minus mean norm value after migration, depends on how the category boundaries intersect the population distribution, but the maximum mean norm value change toward the original norm throughout the evolutionary process is determined by the category width (Fig. 4A). This maximum mean norm change then determines the new equilibrium (Fig. 4B).

Fig. 5 shows the equilibrium norm as a function of different category widths. The population converges to the migrant norm when the categories are narrow, reaches an equilibrium norm close to the migrant norm when the categories are intermediate, and maintains an equilibrium mean close to its original norm when the categories are wide. When categories are narrow (width 0.01 to 1.71 in Fig. 5), similarity-based payoffs have little effect on the mean norm and cannot counteract migration. When the category width is intermediate (1.71 to 3.93), discretized norm effects can counteract migration when the focal population's mean reaches a value close to the migrant norm such that migration's effect on the mean is small. At this time, discretized norm effects may increase or decrease the mean, depending on how the categories intersect the population distribution. Therefore, the focal population's new mean norm may be more different from its original norm than the source population's norm is. When categories are wide (width greater than 3.95), discretized norm effects can

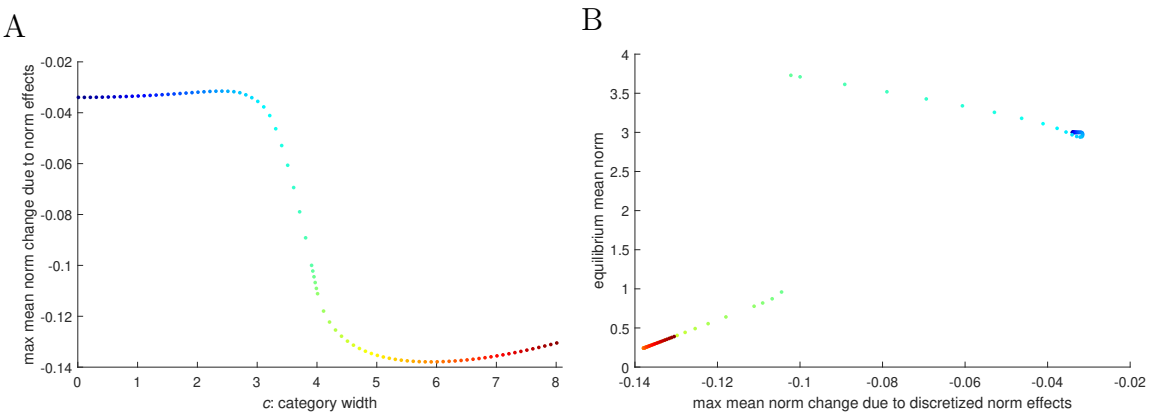


Figure 4. Mechanism of Norm Maintenance by Discretized Norm Effects

Discretized similarity-based norm effects can maintain a continuous norm because they can counteract the external forces' effects on changing the mean norm; bigger categories are more effective. The colors of the circles from cold to hot indicate the category widths from small to big. (A): The maximum mean norm change due to discretized similarity-based norm effects given different category widths. The maximum mean norm change is identified by comparing the mean norm change in each generation. Wider categories are better able to bring the population mean norm to the opposite direction of migration's effects . (B): Equilibrium mean norm as a function of the maximum mean norm value change due to discretized norm effects. When the maximum mean norm change due to discretized norm selection is large, the new equilibrium in the focal population is close to the original equilibrium; when it is small, the new equilibrium is close to the migrant norm. The focal population's initial distribution is solved by having the population evolve under discretized similarity-based norm effects and social learning, but not migration. It has a mean norm of 0 and a variance from 4.32 to 4.87, depending on the category width, which varies from 0.01 to 8.01. Source population mean norm z=3; source population distribution variance U=4.32. Migration rate $m = 0.05$. Similarity-based norm effect coefficient S=10. Social learning is of the continuous norm value, with error $E \sim N(0, 1)$.

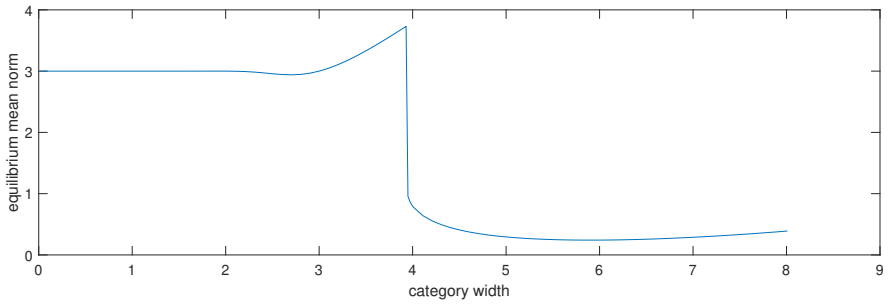


Figure 5. New Equilibrium Mean Norm with Migration Given a Category Width

Wider categories can maintain the focal population's original norm against migration, while narrower categories cannot. Parameter values are the same as in Fig. 4

cancel a big mean norm change due to migration, thus maintaining a new equilibrium norm close to the original norm. Within this category width range up to a certain value, the wider the categories, the more similarity-based norm effects counteract the external forces, and the closer the new equilibrium norm is to the original norm. When the categories are even wider, the center category, which has the highest norm payoff before migration starts, covers more migrants, so discretized norm effects do not penalize the migrants as effectively and the focal population can only maintain a new norm farther away from the original one.

Multiple Optima Can Maintain Norm Variation

Norm variation may be maintained when similarity-independent direct payoffs have multiple optima. Take which side of the road to drive on as an example: instead of "left" and "right", we can describe norms about where to drive in terms of the portion of the road on the left side of the car, a continuous variable. The payoff function would then have two optima: 0.2 or 0.8, corresponding to driving on the left or the right of the road. While 0.5, the norm that has everyone driving at the

middle of the road, has a low payoff because oncoming cars will collide. Because of the payoff valley, the continuous norm describing where to drive has the dynamics and stability properties of a discrete norm: The norm could be either driving on the left or driving on the right, and will be maintained once established. Multiple optima may also result from multiple cognitive "attractors" (e.g., Feldman, Griffiths, and Morgan 2009; Scott-Phillips 2017; Kalish, Griffiths, and Lewandowsky 2007; Falandays and Smaldino 2022), which exist because some cultural variants are easier to learn or remember (Richerson and Boyd 2005; Eriksson and Coultas 2014). Cognitive attractors have been proposed to lead to the maintenance of norm variation among groups in a structured population, as in share cropping contracts in Illinois studied by Young and Burke (2001). We model this situation by modifying the base model to include a "cognitive payoff", which is the sum of multiple Gaussian functions each with one cognitive attractor as its peak. For simplicity, we keep each Gaussian function's width constant and have the cognitive payoff range from 0 to 1, but vary the distance between adjacent cognitive attractors (Fig. 6A).

If the distance between adjacent cognitive attractors is sufficiently large, then different populations can maintain different equilibrium norms against group contacts or direct effects (Fig. 6B). Here the multiple equilibria do not arise from similarity-based norm effects, but are the result of multiple cognitive attractors or other payoff effects with multiple optima.

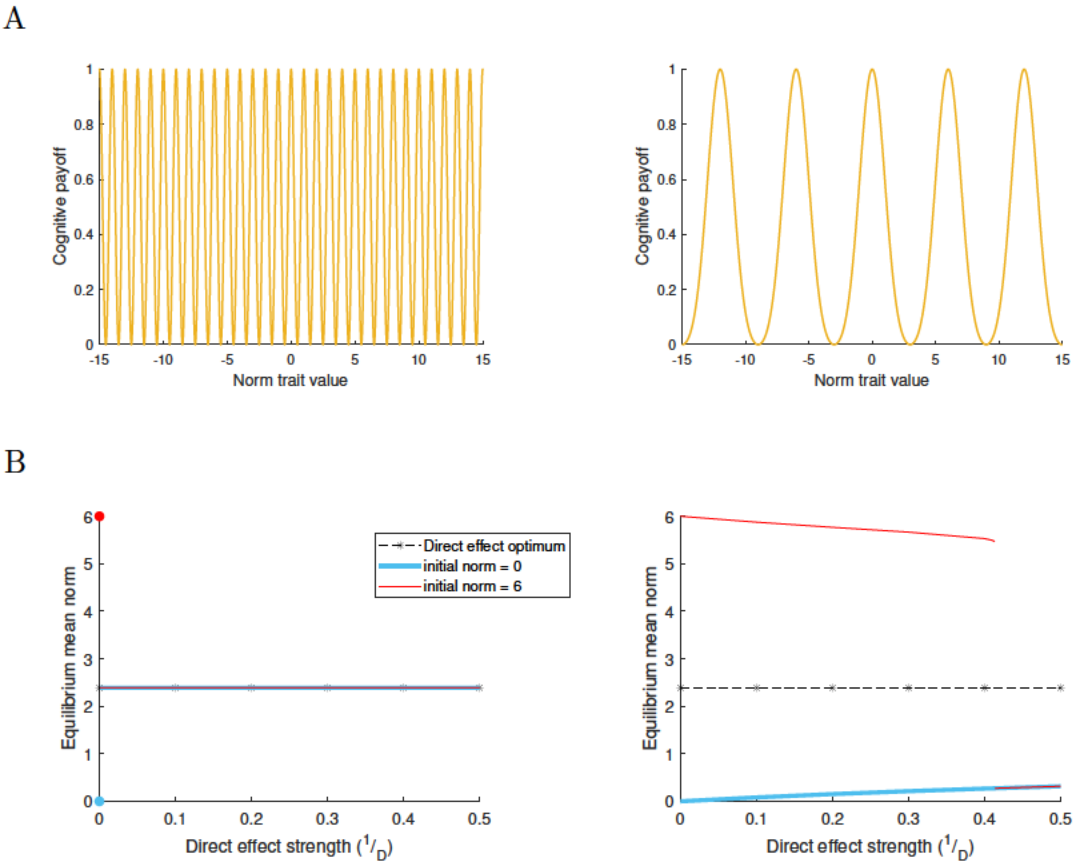


Figure 6. Sparsely Distributed Cognitive Attractors Can Maintain Norm Variation

(A) shows the payoff resulting from closely spaced cognitive attractors (left) vs. sparsely spaced cognitive attractors (right). The payoff in cognitive effects ranges from 0 to 1, peaking at the cognitive attractors and reaching a minimum at the midpoints between them. (B) shows the equilibrium mean of two populations with initial mean norm values of 0 and 6 as a function of the direct effect strength. In the left panel, the cognitive attractors are closely spaced, and the population's norm converges to the optimum in direct effects regardless of the initial norm; In the right panel, the cognitive attractors are sparsely spaced, and populations remain close to their initial norm value until the direct effect becomes strong enough that the cognitive attractor impacting the populations at equilibrium is the one closest to the direct effect optimum (in this case 0). The populations then converge on a equilibrium mean norm between the direct effect optimum and the cognitive attractor in action. Parameter values: optimum in direct effects θ=2.39, coefficient of similarity-based norm effects S=4, social learning error magnitude E=1. The focal population's initial mean norm before migration starts is 0 or 6. The initial trait distribution is not normal because of the multiple cognitive attractors. Its variance is 3.28 for cognitive attractor distance 1 and 2.79 for cognitive attractor distance 6.

Robustness Checks

The analytical work described in the main text shows that when a norm has continuous variants, similarity-based normative payoffs do not lead to multiple stable equilibria. Instead, direct payoffs determine the equilibrium state of the population. Nor can similarity based payoffs maintain variation in norms in a structured population when there is migration. Here we describe numerical simulations that suggest that these results persist under range of alternative parameter values, alternative initial distributions, alternative payoff functional forms and alternative behavioral space constructions. This appendix describes these robustness checks.

1. Alternative parameter values

In the section "Similarity-based payoffs do not maintain variation among subpopulations in a structured population", the norm evolves under the following parameter values: migration rate m=0.01, source population norm z=3, source population variance U=0.1, social effect coefficient S=2, social learning error magnitude E=1. Different parameter combinations, including lower migration rate (m=0.0001), stronger normative effects (S=0.01), smaller or bigger source population distribution variance (U=0.01, U=10), smaller or bigger social learning error (E=0.1, E=10) and their combinations do not change the qualitative results. The parameter values only impact how fast the norm evolves.

2. Non-Gaussian payoff functions

In the main text, the pairwise similarity-based normative payoff is given by $\ln W_S(x_i|x_j) = -(x_i - x_j)^2/2S$, so it decreases with the partners' norm trait value difference log-quadratically. With the following alternative forms of $W_S(x_i|x_j)$, which all

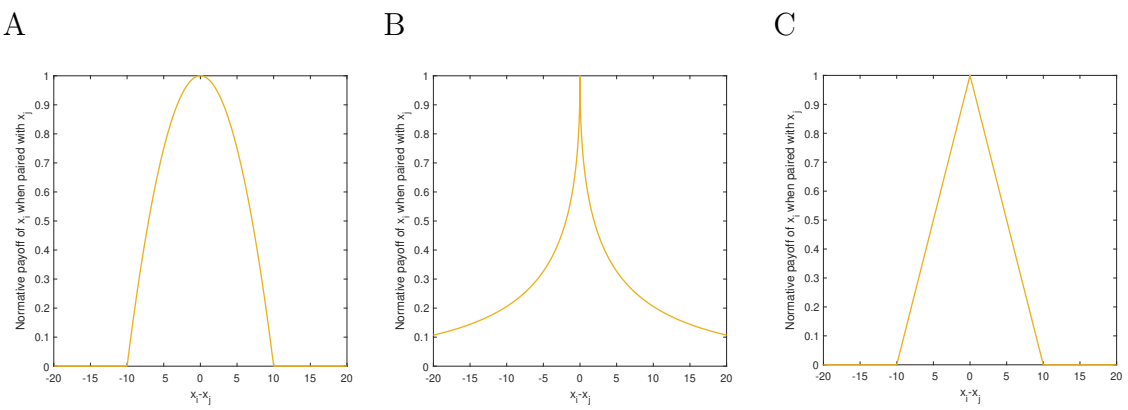


Figure 7. Alternative Pairwise Similarity-Based Normative Payoff Functions with Different Curvatures

Implementing a pairwise norm payoff function with these alternative curvatures does not change the qualitative results. A: Concave norm payoff with $S = 10$. B: Convex norm payoff with $S = 4$. C: Linear norm payoff with $S = 10$.

peak at $x_i - x_j = 0$ but decreases with $|x_i - x_j|$ in ways specified by the following functions: 1) $W_S(x_i|x_j) = \max(-[(x_i - x_j)/S]^2 + 1, 0)$; 2) $\ln W_S(x_i|x_j) = -\sqrt{|x_i - x_j|/S}$; and 3) $W_S(x_i|x_j) = \max(-|x_i - x_j|/S + 1, 0)$ (Fig. 7), the continuous norm evolves to the unique equilibrium favored by the external force like in the base model.

We also implemented the direct effect payoff $W_D(x_i|x_j) = \max(-[(x_i - \theta)/D]^2 + 1, 0.01)$; 2) $\ln W_D(x_i) = -\sqrt{|x_i - \theta|/D}$; and 3) $W_D(x_i) = \max(-|x_i - \theta|/D + 1, 0.01)$. The equilibrium mean is equal to θ when we alter either only the form of the direct effects or both the direct and normative effects payoff functions, although the evolutionary process can be extremely slow if both direct effect and normative effect payoff functions have flat regions (i.e., form 1 and form 3) and the population starts from an initial distribution where most of the mass does not overlap with the elevated payoff region of the direct effects payoff function.

To model situations in which the direct effects payoff function, $W_D(x_i)$, is monotonic

in x_i, we construct W_D as follows: $\ln W_D(x_i) = \frac{x_i}{D}$. A positive D indicates the direct payoff increases with x_i, whereas a negative D indicates the direct payoff decreases with x_i. Following the same procedures as in *Appendix B*, we can calculate the payoff-transformed population distribution $\phi\prime(x) = W(x)\phi(x)/\int W(x)\phi(x)dx$, where $W(x)\phi(x) = \exp\left\{\frac{(x-\tau)^2}{2T} - -\frac{x}{D} - \frac{(x-\mu)^2}{2V}\right\}$ (See *Appendix B* for the values of T and τ in the base model and in different extensions). Then we expand the exponent E and complete the square.

$$\begin{aligned} E &= -\frac{(x-\tau)^2}{2T} - \frac{x}{D} - \frac{(x-\mu)^2}{2V} \\ &= -\left(\frac{DV+DT}{2DVT}\right)\left[x - \left(\frac{TV+DV\tau+DT\mu}{DV+DT}\right)\right]^2 \\ &\quad + \left[\frac{(TV+DV\tau+DV\mu)^2 - (DV\tau^2+DT\mu^2)(DV+TD)}{2DVT(DV+DT)}\right] \end{aligned}$$

which gives us

$$\phi'(x) = \frac{\sqrt{DV+DT}}{\sqrt{2\pi DVT}} \exp\left[-\frac{x - \left(\frac{TV+DV\tau+DT\mu}{DV+DT}\right)}{\frac{2DVT}{DV+DT}}\right]^2$$

Since social learning is payoff-biased with an unbiased error, the recursion of the mean μ is $\mu_{t+1} = \frac{TV+DV\tau_t+DT\mu_t}{DV+DT}$. In the base case, where two individuals interact and payoff is the similarity-based normative payoff with no preferred deviation, we have $\mu_{t+1} = \mu_t + \frac{V^2+SV}{(2V+S)D}$. Therefore, the mean norm will increase indefinitely if $D > 0$ and decrease if $D < 0$. The same is true when the similarity-based normative interactions are with $n-1$ partners. When the similarity-based normative interactions involve a preferred deviation δ, the recursion is $\mu_{t+1} = \mu_t + \frac{V}{2V+S}(\delta + \frac{V+S}{D})$, so if the preferred deviation and the direct effects act in different directions, the norm will either increase or decrease depending on the relative magnitudes of the preferred deviation and the strength of direct effects relative to the strength of normative effects and the population distribution variance.

Non-Gaussian initial norm distributions

It seems plausible that if the initial distribution of norm values were multimodal this would create disruptive selection that would maintain the mulitmodal distribution at equilibrium. To test this intuition, I initialized the distribution of norm values in the population to be multimodal, discrete, or uniform, and then tracked the evolution of norm trait distribution by numerically integrating the resulting equations. When there is no external force, but only similarity-based normative effects and social learning with error, the equilibrium distribution was normal in all simulations (Fig. 8B). This occurs because individuals close to one peak of the distribution are pressured to be similar not only to partners close to the same peak, but also to partners close to the other distribution peak(s). Consequently, the local optimum in normative effects corresponding to one distribution peak is shifted toward the other distribution peak(s), and eventually the local optima converge. The equilibrium distribution's mean depends on the precise shape of the initial distribution if it is not uniform.

We also initialized the population with 1) multimodal continuous distributions with 2, 3, or 4 peaks, 2) discrete distributions with 2, 3, or 4 values, and 3) uniform distribution spanning different norm value ranges, and simulated the evolution of the population norm trait distribution with similarity based payoffs and direct effects or migration. Regardless of the initial distribution, the equilibrium distribution was unimodal in all simulations (Fig. 8C) and the equilibrium mean norm is the value favored by external forces (Fig. 8D). In Fig. 8, we present one example from each distribution category, with direct effects as the external force.

4. Discrete bounded behavioral space

With normally distributed continuous error, the population's norm traits need to be divided into a few large categories for discretized similarity-based normative payoffs to maintain multiple equilibria with a continuous norm. This is true no matter whether the naive individuals try to copy the continuous trait values of the models or their categories. Discretizing three processes is equivalent to discretizing the behavioral space. We study the impact of a discrete behavioral space by dividing the norm traits and the error into the same set of categories, such that through the norm evolutionary process, the only possible norm traits are the center values of these categories. The results are qualitatively the same as discretized normative payoffs—large categories can allow similarity-based normative payoffs to maintain a continuous norm at different equilibria in populations with different initial norms, while small categories cannot, but when error is also discretized, the borderline category width for norm maintenance is smaller.

When the behavioral space is bounded, the results depend on how we model what happens to the individuals who would have acquired norm values outside of the behavioral space due to the model they chose and the social learning error they made. If we assume they acquire the norm values on the border, then erroneous social learning skews the population norm value distribution toward the borders, and the behavior of the model changes depending on the behavioral range's position relative to the initial norm. If we assume the individuals who would have acquired out-of-boundary norm values repeat social learning until they acquire a value within the behavioral range, then a bounded behavioral space gives the same qualitative results as the base model—the equilibrium mean norm does not depend on the initial norm or the strength of similarity-based normative effects.

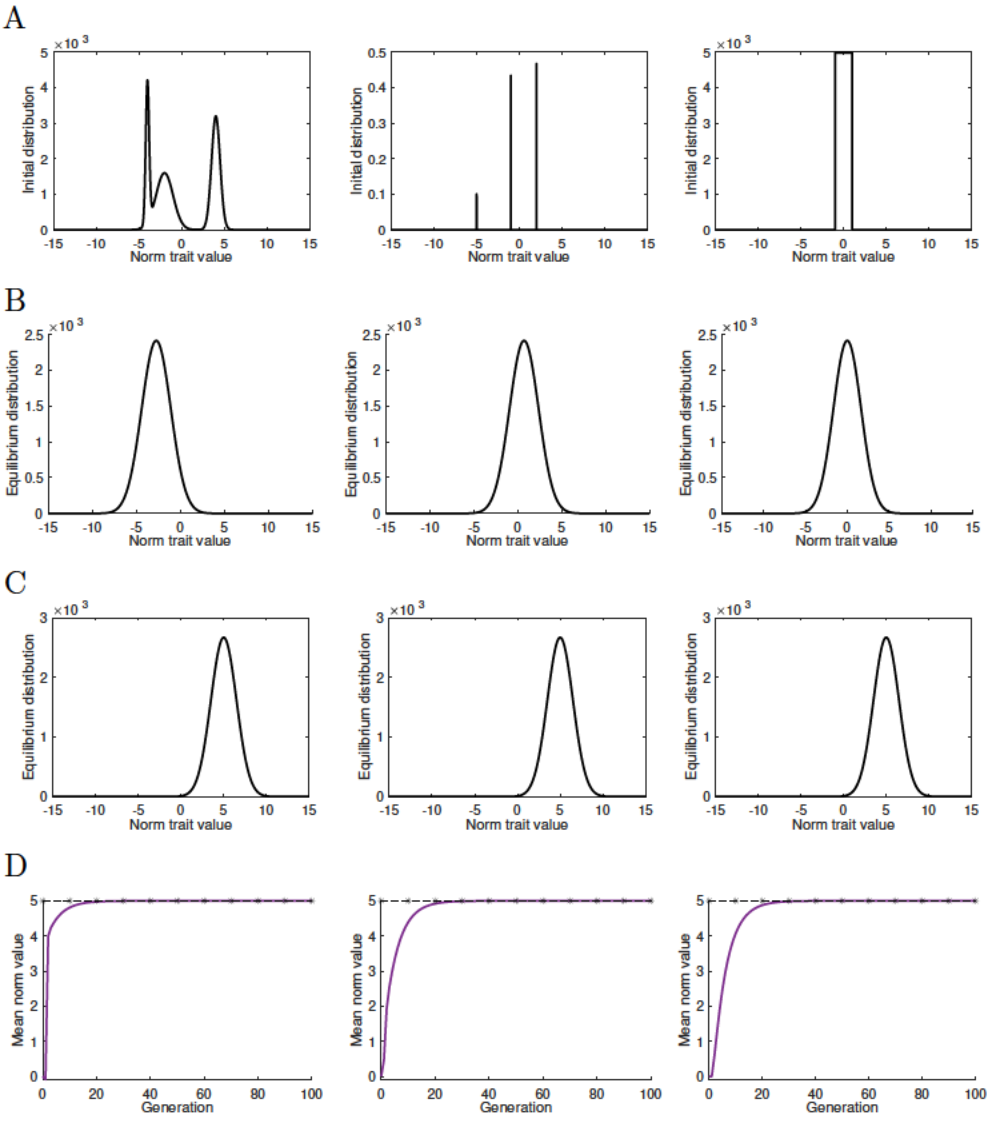


Figure 8. Continuous Norm Evolution with Alternative Population Initial Distributions

Fig. 8A shows the alternative initial distributions considered. Left: multimodal distribution. Middle: discrete distribution. Right: uniform distribution. Fig. 8B shows the equilibrium distributions corresponding to the three initial distributions when there is no external force, but only similarity-based norm pressure and payoff-biased social learning with error. Fig. 8C shows the equilibrium distributions when there is direct effects, while Fig. 8D shows how the population mean norm changes each generation under such direct effects. All three initial distributions have a mean of 0. Parameter values: coefficient of norm effects S=2, social learning error magnitude E=1, direct effects optimum $\theta = 5$, and coefficient of direct effects D=10.

Discussion

Many researchers believe that norms are maintained by similarity-based payoffs (e.g., H. Peyton Young 2015) which reward people who do what others do and penalize those who do not. Models with discrete choices confirmed this intuition. When norm variants are discrete, similarity-based payoffs can allow the norm to withstand perturbations from environmental changes and inter-group contacts. Multiple stable equilibria are possible and the norm common in a population at equilibrium depends on the population history. Shifts occur when big perturbations push the behavioral composition of the population past a tipping point, and when such shifts occur, they happen quickly.

In contrast, the model analyzed here shows that similarity-based payoffs do not sustain continuously varying norms against even arbitrarily small perturbations. When there are direct effects from ecological environments, moral preferences or cognitive processes, or if there are demographic processes like migration or interaction between subpopulations, a continuous norm subject to similarity-based payoffs keeps evolving until it reaches a single equilibrium determined by these forces. This occurs because the optimum in norm-similarity-based interactions evolves along with the mean norm.

Both discrete and continuous norms exist. The behavioral space for some norms is discrete. For example, a man may be allowed only one legal wife at once, or two, or three, but not 1.253 wives. For other norms, the space of possible behaviors is continuous. Examples include how far away to stand when talking to someone, how loudly you can talk on the public transit, how long you can keep a borrowed item, how much to spend on a gift for a friend's wedding, how to pronounce the "a" in tomato, or what color hues are permissible to wear to a funeral. Even norms that classically are conceived of as discrete vary continuously when we consider the full range of possible

behaviors. Where to drive can be described as the proportion of the road on the left side of the car instead of "left" vs. "right". Although labeled as either matrilocal or patrilocal, post-marital residence norms can have the couple stay different lengths of time with the parents of the husband vs. the wife. Foot-binding can vary by age of binding and eventual length of feet.

Our results suggest two ways in which we can recover discrete norm dynamics in such cases. First, continuous variants can be subject to multimodal direct effects, meaning that there are multiple locally optimal norm trait values created by the external forces. For example, in the case of post-marital residence, external forces could be due to gains from alloparental care, conflicts with in-laws, and resources needed to establish a separate household. Suppose due to these external forces, living with the wife's parents has maximum direct payoffs, followed by living with the husband's parents, while arrangements that involve re-locating between them have low payoffs. Then the norm "live with wife's parents" and the norm "live with husband's parents" can both be maintained in different sub-populations. Second, our cognitive or cultural constructs can cause us to partition the continuous behavioral space into a few broad categories such that behaviors within a category are perceived to be the same. For example although the acoustic signal for "a" may vary continuously, discontinuities in low-level auditory processing, or culturally learned phonological categories may lead us to bin the continuous variation (Toscano et al. 2010).

To illustrate how different forces impact norm evolution, again consider the tipping norm in the US. We consider five cases. In all of them, the external force is the monetary cost of tipping, and so the optimum is to not tip. Case 1: The only social pressure is to do what most people do. Here the external force determines the equilibrium, and the norm will evolve so that at equilibrium there is a low level of

tipping due to transmission error. Case 2: Instead of favoring the common behavior, social evaluations involve a moral judgment that rewards an upward deviation from the common behavior, such that say tipping 2% more than the current custom yields the highest social payoff. Now, the tipping norm evolves to a unique positive equilibrium $\frac{D}{V+S} \times 2\%$, with V indicating the tipping behavior's variation in the population, S indicating the tolerance of normative effects and D indicating the tolerance of direct effects. Therefore, if deviations from the norm strongly reduce one's reputation, but the monetary cost is not that severe, a preferred 2% deviation can maintain the tipping norm at a value much higher than 2%. Case 3: Moral judgment penalizes tips lower than the custom, but gives the average tip and anything bigger the same maximum payoff. Again, moral judgment maintains a positive tipping norm at equilibrium. Case 4: There are multiple cognitive attractors among the tipping percentage options. For example, nowadays, many merchants in the US offer 15%, 18%, 20% and 25% as suggested tip options. Any other tip requires additional calculations. If the distance between these cognitive attractors is big enough compared to the range of tipping percentages among customers, the tipping norm can by sustained at a value slightly below the cognitive attractor in action, and regional differences can exist despite contact between groups. Case 5: The continuous tipping behaviors are perceived discretely. For example, because of the cultural construct of the decimal system, we may only distinguish whether a tip is between 0 and 10%, between 10% to 20%, or between 20% to 30%, but not differentiate tips within the same 10% range. In this case, the social pressure to do what others do can maintain the tipping norm at different levels based on the populations' traditions.

The second example is an ethnographic instance from the first author's field site. Among one group of Derung people, an ethnic group in China, there is a norm that

specifies that households that cooperate in farming should divide the harvests equally by household, regardless of how many laborers each household contributed or who provided the land. This norm is still largely followed in practice although recent market integration has greatly increased the value of labor and land, and most people (75%) prefer dividing in proportion to the number of frequently attending laborers and know that most others also prefer this labor-based division. The range of possible division behaviors is continuous and the behavioral space is well utilized: According to the subjects' self-reports, which may have been impacted by household division being a cognitive attractor and under mental categorization, the actual divisions include: no additional amount of the harvest rewarded to the household providing an extra laborer, rewarding the household an additional 1%, 2%, and 10% of the harvest, dividing in proportion to typical labor contribution, and giving all of the harvest to the household with more laborers. Based on the first author's work, all three continuous-norm-maintaining forces identified in this paper are operating. Derung people in the study village have moral preferences that make it acceptable to give their partners more but not acceptable to take more. People do not seem to perceive differences in labor contribution and often fail to recall small deviations from equal division, suggesting that equal division might be a cognitive attractor. Small deviations from equal division are usually accepted by partners and approved by third-parties because they are "pretty much the same", indicating that the continuous variation is perceived as discretized chunks. Therefore, we should expect that the existing norm will influence the new equilibrium norm under changed ecological, economic and social conditions, and that the normative practice need not necessarily converge to what is favored by external forces. This may explain the persistence of the "equal division by household" norm despite the ecological shift that pushes towards division by labor.

The findings in this paper have implications for understanding the role that norms can play in sustaining human cooperation. Norms are considered to be a key factor in allowing humans to cooperate to produce public goods and solve collective action problems. However, many cooperation norms have continuously varying options, for example, how much money you contribute to a local community fundraiser, how much labor you contribute to the building of a drift fence, or how much risk you subject yourself to in war. Given our result, if the cooperation norm favors the average behavior, it quickly erodes to the individual selfish optimum. However, empirically, we frequently observe cooperation norms that are costly to individuals. The model above suggests that these norms likely owe their existence to evolved moral preferences for high contributions. This also implies that gene-culture coevolution, wherein prosocial preferences are genetically encoded, would have been far more effective than cultural evolution by itself in facilitating human cooperation.

The inability of similarity-based payoffs to maintain different continuous norms poses a challenge for cultural group selection. Without different moral beliefs among groups, multiple cognitive attractors, or highly discretized social evaluations, there will be no variation among groups for selection to act on. Measurements of cultural F_{ST} values, however, do indicate that even though the majority of variation is between individuals, there is sufficient between-group variation in social norms (Bell, Richerson, and McElreath 2009; Handley and Mathew 2020; Muthukrishna et al. 2018; Smith et al. 2018) for cultural group selection to be a non-negligible force. This suggests that forces other than "doing what most others do" may play a role in maintaining differences among neighboring groups. Variation could be maintained by differences in direct effects in different groups, as would happen if the groups for example differed in subsistence modes, cultural knowledge or beliefs, moral reasoning, or meta-norms

governing social evaluation. Alternatively, it could be because the behavioral space has multiple cognitive attractors or discrete categories and each group converged to a different attractor or category based on initial conditions, and the pressure to do what others are doing maintains this difference.

The ability of a continuous norm to evolve to the individual optimum means groups can adapt to their environments even if their previous maladaptive practices are enforced and deviations are penalized. This is consistent with cross-cultural analyses showing a link between social norms and ecological factors. For example, norms surrounding land ownership are linked to defendability and environmental stressors (Ember et al. 2020), and norms supporting patriliny, polygyny, and male-biased wealth inheritance are linked to pastoralism (Holden and Mace 2003; Mace and Jordan 2011). Matrilocal residence is associated with external warfare, and greater female contribution to subsistence labor (Ember and Ember 1971). The fact that continuous norms can respond to ecological pressures more easily also means that many historical practices of societies may not be as arbitrary or path dependent as previously assumed. Rather, there may be continued external pressure that maintains many of these norms. It may also not be necessary to shift a sufficient number of people's normative expectations and beliefs to achieve norm change in many situations. Rather manipulating external pressures may be more effective in these circumstances.

This work has seven limitations that might impact the generality of its conclusions. First, it assumes that people adopt norms according to the observed payoffs of different norm trait values. Sometimes people can predict that the future will be different from the past. Then a norm may be maintained until some event occurs and serves as a signal for people to coordinate a behavioral shift toward the norm they all prefer but have kept as a secret (Kuran 1995). Second, the model assumes that people use

their own behavior as the reference to evaluate their interactants and includes the cost of punishing deviants in the similarity-based norm effects. If individuals who do not follow the norm themselves can achieve higher social payoffs by punishing other deviants, if punishing is ecological beneficial, like when it takes the form of stealing from deviants, or if there are secondary norms about who are to punish and how to punish, the association between the population norm trait distribution and the payoffs may not be as straightforward and consistent as in the current model, and the evolutionary dynamics may change as a consequence. Third, we only considered the impact of a simple form of within-population heterogeneity based on group identity and status—when the migrants have no social power. Group identity could affect norm evolution in many ways and can have important impacts on our results. Fourth, we only considered norm evolution under blending inheritance, where naive individuals acquire the average norm of the social learning models, and we assumed the error is unbiased. Other forms of social learning and error may change the result. Fifth, in addition to the pressure to be similar to others, social norms are often accompanied by moral preferences, group identity signaling, or other social considerations. We have shown that preferred deviation and one-sided sanctions cannot restore similarity-based payoffs' ability to maintain a continuous norm at different stable equilibria, but there may be other social forces that can. Sixth, our conclusion that assortment and direct effects on groups do not change the behavior of the model may depend on the way we implemented assortment and constructed group payoffs. Finally, we assume that populations are very large, and in small populations random effects could be important. Nonetheless, by highlighting how continuous norms can have qualitatively different dynamics, this work brings attention to the need for further analysis of continuous norm evolution and the importance of incorporating cognition in such analysis.

Chapter 3

A REVIEW OF DERUNG HISTORY, SOCIETY, AND CULTURE

Introduction

The Derung are an ethnic group living at the border of China and Myanmar. I chose the Chinese Derung living in Derungjiang Xiang[1], Gongshan County, Nujiang State, Yunnan Province in southwest China to study how norms are maintained and how they change, because Chinese Derung people have experienced recent market integration events. These market integration events have introduced new ecological, economic, and social pressure on the Chinese Derung and the Derung norms may change as a result. Given that any new norm not only has to replace the old norm that governed behaviors in the same context, but also fit into the more general socio-cultural environment, it is important to build a holistic view of Derung society and culture. In this chapter, I review the ethnographic information about Chinese Derung living in the Derung Valley, focusing on both traditional lifestyles and modern changes, to provide background for the Derung co-farming division norm to be analyzed in the next chapter. The discussion on Derung living in Myanmar will be brief because there is insufficient work on the Myanmar Derung and my fieldwork does not involve the region.

[1]A "Xiang" is a Chinese administrative unit below a county, above a village and smaller than a city.

Modern and Historical Politics of Derung

Derung as an independent nationality

The "Derung" are also known as "Dulong", "Drung", "T'rung" "Tvrung" and "Qiu". In early English and French writings, the group name was also written as "Tourung", "Taron", "Tarong" or "Trun" (Gros 2004). The Derung were recognized as an independent minority nationality (Mandarin: shaoshu minzu) in the nationality identification project carried out in the 1950s. The status of Derung as an independent nationality, and as the nationality with the smallest population size in China, lead to substantial attention from the PRC government and consequently, dramatic social changes from 1950 up to the present. I will start by introducing how Derung gained their status as a nationality. Many believe that the identification and naming of Derung in the nationality identification project resulted from the meeting between KONG Zhiqing, the Derung's self-elected civilian district major in the 1950s, and ZHOU Enlai, the prime minister of PRC at the time. KONG Zhiqing documented this interaction (Kong 1999):

> On Jan. 4, 1952, ZHOU Enlai and other PRC officials met with Chinese minority nationalities' representatives at the central nationality committee extended meeting in Beijing. ZHOU Enlai kindly shook hands with every representative and asked them what their names were, where they came from, and what nationality they belonged to. When Prime Minister Zhou came to me, I was so excited that my heart was jumping out of my chest. I held Prime Minister Zhou's hand and said, "My name is KONG Zhiqing. I came from the most distant part of Yunnan, Derungjiang (Derung River). Our nationality used to be called 'Qiuzi'. We call ourselves 'Derung'."

> Upon hearing this, Prime Minister Zhou said to the southwest department director, WANG Weizhou, who was next to him, "WANG, remember, the nationalities' names should be based on what they call themselves, not what other nationalities call them." At that time, I teared up from excitement, because after this meeting, our nationality was officially identified as the Derung nationality. This is not just another nationality identification. It represents the ending of Derung people's history of getting discriminated, and shows that we have officially become an equal member of our country's family of nationalities.

The Derung people saw the recognition and naming of their group as a result of their desire for this outcome and its communication to government officials. From the government's perspective, however, the people's desires were probably only one of the many elements that were considered in the nationality identification project. After all, more than 400 nationalities were registered at the beginning of the nationality identification project, but only 56 were eventually recognized. From historical records, it seems that the identification of Chinese Derung as an independent nationality was at least partially due to the fact that previous governors and other nationalities all recognized Derung ("Qiu") as an independent unit (Gros 2004; L. He 2011). Therefore, the current political status of the Chinese Derung resulted from their past political status.

Historical political influences

Because the Derung did not have a writing system and lived in relative isolation, there are few historical records on them. The Derung are first mentioned in "Yuan YiTong Zhi", written in 1286 A.C., but there was no description of their society or culture

(YANG Yan, 2017). Therefore, there is no way to tell whether the people bearing the same exonym were the ancestors of the current Chinese Derung. Some informants in the 1950s reported that their clan came to their current residence location 13 generations ago. This testimonial coincides with the documents on "Qiu" from the Qing Dynasty, the first written in 1735 (Y. Yang 2017). Therefore, it is safe to say that modern Chinese Derung has a history of at least about 300 years, and maybe 750 years.

According to LI Ya-feng (Li 2018), the political forces acting on Derung people before the Republic of China's government established direct governance in 1912 mainly came from chiefs from other ethnic groups that were appointed by ancient Chinese dynasties, and from Lamaist churches. The details, however, are often missing. The first record of politics touching the Derung Valley is associated with a war. The Mu family, ethnically Nakhi, had been hereditary Lijiang Tuzhifu (local prefecture administrators) since 1253 (FitzGerald and Rock 1949). Sometime between 1573-1620, they won a war with Tibetan chiefs, conquered Weixi and then went further to arrive in upstream Nu Valley and upstream Derung Valley. The Mu Tuzhifu then left Mu-surnamed hereditary military directors behind to govern this region. These military directors were stationed at Kangpu village along Lancang (Mekong) River and were known as Kangpu chiefs. They focused mainly on managing the people in Lancang River Valley, and paid little attention to people living in Nu Valley, let alone to Chinese Derung who lived one more mountain range to the west. This only changed in 1728, when the Kangpu chief's territory was greatly reduced by Qing Yongzheng Emperor[2] 's frontier political system reformation. Therefore, external political forces entered upstream Chinese Derung's life no earlier than 1728. The downstream Derung

[2]Yongzheng was the fifth emperor of the Qing Dynasty. He ruled from 1722 to 1735.

were integrated into ancient China's "central government — Tuzhifu — local chief" political system even later, after Mu-surnamed Kangpu chiefs' line ended in 1810 when the newly appointed Kangpu chief and chief assistant expanded their power into downstream Derung Valley.

Later Yezhi chiefs also came to govern the Chinese Derung. In 1875, the Yezhi chiefs were promoted by the Qing government and extended their power to downstream Derung Valley. Then in 1902, the Kangpu chief was dismissed because of "BaiHanluo JiaoAn" (the event in which Lamaist believers in Nu Valley burned a Catholic Church directed by French missionaries under the encouragement of Lamaist churches) and Yezhi chiefs replaced Kangpu chiefs and started governing the whole Derung Valley region.

In addition to chiefs from other ethnic groups, Chinese Derung were governed by Lamaist churches. Lamaist churches from Tibet were granted the power to collect taxes from upstream Nu Valley region and upstream Derung Valley region by the Kangpu female chief *HE*[3] sometime between 1728 and 1753 (Li 2018), either because Tibetan Lamaist monks helped treat her sick son (Gros 2011) or because they performed rebirth rituals for him after he died (Editing committee for Records of Gongshan Derung Nationality and Nu Nationality Anonymous County 2006). In 1825, another Lamaist church was built in Bingzhongluo, Gongshan, and also claimed rights to the people nearby. The local chiefs and Lamaist churches both collected taxes and requested labor from the Chinese Derung people.

The local chiefs and Lamaist churches mainly brought the Derung abuse and exploitation. Only Kangpu, and later on, Yezhi chiefs, were granted the right to

[3] *HE* was the wife of a hereditary Kangpu chief. She acted as the Kangpu chief after her husband died because their son was still young.

collect taxes from the Nung and the Derung by the Qing central government, and they were supposed to defend the frontiers and manage the people. They, however, collected more taxes than permitted and did not care about the people's quality of life. XIA Hu, a Qing dynasty officer, (1908) writes:

> Although there are chiefs, all they do is to collect money and crops. They do not station armies and do not manage the people. They not only do no good but also bother the people... As to Qiu (Derung) River Valley, they are supposed to be the people of Weixi (a sub-department of Lijiang local government) and they pay money and crops to the chiefs. However, because the chiefs never come to this region, there is no one who actually manages the people. This leads to Qiu people being bullied by Tibetan monks and raided by other groups. Qiu people were almost not able to live.

The local chiefs and Lamaist churches forced the Nung and the Derung to pay many different taxes and perform free work (Editing committee for Basic situations about Gongshan Derung and Nu Autonomous County 2008) and forced them to trade items at unfair rates (Xia 1908). When people could not pay enough, the chiefs and churches whipped them and took them as slaves. As a result, the Derung people could hardly accumulate any wealth.

From XIA Hu's descriptions, we can see that Derung were also at a disadvantage in interactions with other ethnic groups probably because their population size was smaller than any of their neighboring groups, and because they had inferior tools and fighting weapons. Lisu, Tibetan, and Nung people raided and enslaved Derung and used Derung slaves to pay taxes (Gu 2012). One explanation for the Derung custom of female facial tattoos is that it prevented Derung girls from getting taken by other

ethnic groups. These other ethnic groups also routinely extorted tribute from the Derung in return for exemption from raids and charged extremely high interest rates on loans to Derung. These negative interactions may have contributed to Derung's "shy and cowardly" nationality personality (Fu and Dong 1763).

The exploitation by local chiefs and Lamaist churches and the bullying by other ethnic groups were reduced but not eliminated when Kuomintang entered in 1912. XIA Hu visited Derung Valley in 1904, named local leaders, and told them that the Derung were Qing Dynasty's people and should not pay taxes or tributes to the Tibetan and the Lisu, but such exploitation quickly resumed after XIA Hu left because the Qing dynasty did not have the power to control the local political forces. Kuomintang established direct governance in Gongshan County in 1912 and appointed prestigious family community heads and household leaders as village directors. According to Basic Situations about Gongshan Derung and Nu Autonomous County (2008), Kuomintang's governance was also exploitative. For example, they collected "airplane watching fees" when an American airplane flew over. It is unknown whether such exploitation was the individual doing of certain greedy Derung village directors or Kuomintang's formal policy.

The Derung were not much affected by WWII, except attempts by the British in Myanmar to spread their power into China. Three groups of British people came to the Derung Valley in the 1920's (Yunnan editing committee for Five Books on nationality issues and Editing committee for Chinese Minority Nationalities' Societies and Histories Survey Documents Series 1985b, p. 20). One group that intended to go to Tibet withdrew to Myanmar after their director was killed by the Derung. Two groups successfully reached the North end of the Derung Valley, but local people did not know what they wanted or where they went afterward. British invasions also

affected the China-Myanmar border. North Kachin belonged to China during Ming and Qing dynasties. In the first half of the 20th century, the status of this region became ambiguous. The current China-Myanmar border was set to lie along the Kaolikong mountain range in 1960 (Editing committee for Basic situations about Gongshan Derung and Nu Autonomous County 2008, P. 60). The Chinese communist party established governance of Gongshan County in Feb. 1950, after their army won the war with the united army of Kuomintang and Dêqên chiefs. From then to Apr. 1953, the PRC government gradually set up the local autonomous government in Gongshan County, as to be described in the next subsection.

Modern Political Units

In the modern Chinese Derung political system, Derungjiang Xiang, in Gongshan County, Nujiang State, Yunnan, China, where most Chinese Derung reside, is divided into 6 administrative villages. Each administrative village is composed of 4-7 actual villages that are close to each other. Henceforth, I will use "village" to refer to naturally formed residence settlements and use "administrative village" to refer to the most basic Chinese political unit, which can be composed of multiple villages. The villages in the same administrative village share an administrative village government and are subject to the same government policies. Therefore, the within-administrative-village differences are usually minimal, while the between-administrative-village differences can be significant. To study modern changes of the Chinese Derung accurately and comparatively, we need to consider the administrative villages individually. In addition, the six modern administrative villages experienced different historical political influences. In some documents, these historical influences are described using the old political divisions in effect from the 1950's to the 1970's and 1980's, or geograph-

ical locations relative to Derung River. I now introduce how the current Derung administrative units correspond to these old divisions.

Currently, Derungjiang Xiang has six administrative villages: Dizhengdang, Longyuan, Xianjiudang, Kongdang, Bapo, and Maku, from north to south (Fig. 9). From the 1950s through the 1980s a four-administrative-village system was in force. In this system, the four administrative villages were "Yixiang" (first town, corresponding to Dizhengdang and most of Longyuan), "Erxiang" (second town, corresponding to a small portion of Longyuan and the whole Xianjiudang), "Sanxiang" (third town, corresponding to Kongdang) and "Sixiang" (fourth town, corresponding to Bapo and Maku). Another commonly seen division system in historical documents about the Chinese Derung is upstream/downstream, or upstream/midstream/downstream, based on a village's geographical location on the Derung River. It is, however, unclear how these units correspond to the six modern administrative villages. I could only safely infer that "upstream" includes Dizhengdang, Longyuan and Xianjiudang, while "downstream" includes Bapo and Maku. When midstream is mentioned, it includes Kongdang. Where Kongdang lies in the upstream/downstream division system, and whether Xianjiudang belongs to upstream or midstream in the upstream/midstream/downstream division system is unknown. If information about the current administrative units cannot be inferred from old records, I will use the geographical or old administrative terms instead.

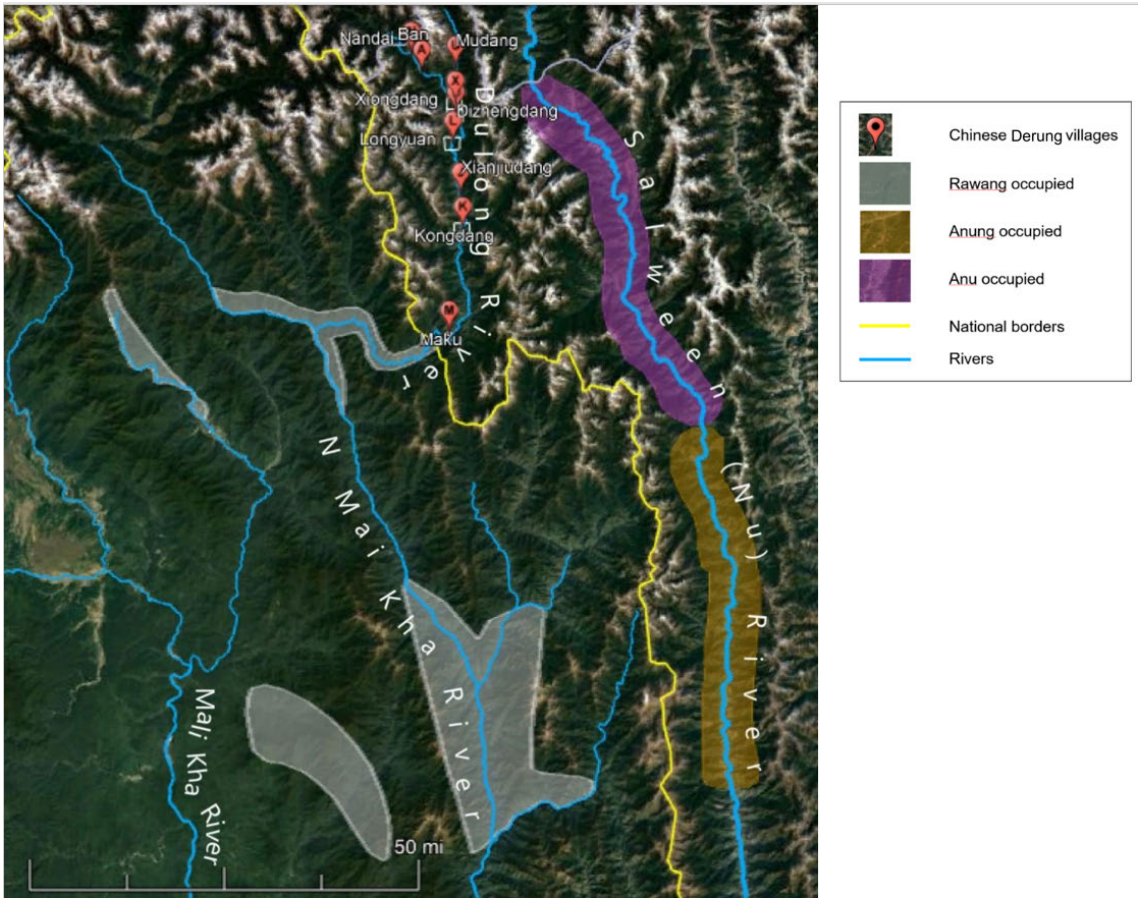


Figure 9. The Distribution of Chinese Derung and Related Ethnic Groups

Nandai, Ban, Mudang, Xiongdang and Dizhengdang are the five different villages composing Dizhengdang the administrative village. They are shown separately in this map because different "groups" in Dizhengdang administrative village are distant from each other.

Other groups related to the Chinese Derung

The boundary for the Derung nationality was set more for political convenience than anthropological rationality (Thoraval 1999; Gros 2004). To understand Derung cultures and societies in a comparative framework, we need to understand where Derung stands in the ethnic phylogeny. The Chinese Derung are most closely related to the Nung in China and Myanmar and the Rawang in Myanmar. All these groups,

including the Derung, belong to the Jinghpaw branch of the Tibeto-Burmese people. Next, I present the evidence for these conclusions.

Researchers believe that the Chinese Derung came from the Chinese Nung people, who live alongside the Nu (Salween) River (HE Lin, 2011). To understand the relationship between the Derung and the Nung, we have to first understand the composition of the Nung. The marker "Nung" is an example of the nationality identification project identifying groups in a politically convenient but scientifically incorrect manner. The Chinese Nung are actually composed of four different subgroups: Anu in Gongshan, Nung (or Anung) in Fugong, Nusu in what was previously known as Bijiang (note 2), and Zauzuo in Lushui. For clarity, I will use Anung to refer to the subgroup and reserve the term Nung for the umbrella nationality henceforth. The Anu and Anung are linguistically related to Jinghpaw (Kachin), while Nusu and Zauzuo are related to Yi. The languages of these two branches are fundamentally different. They were grouped together because they were traditionally grouped together by the local chiefs and by other nationalities. The four groups, however, never shared a common group identity and still recognize themselves as separate people in daily life (HE Lin, 2011).

The Nung subgroups that are believed to have given rise to Derung are mainly Anu in Gongshan, but also Anung in Fugong. The close ties between Anu and Derung are reflected in their languages, their cultures, and their historical interactions (*Basic situations about Gongshan Derung and Nu Autonomous County [Gongshan Dulongzu Nuzu Zizhixian Gaikuang],* p. 26, *Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 2, Gros 2004; L. He 2011). Linguistically, the Anu language and the Derung language are similar grammatically and mutually intelligible, and their vocabularies are similar, with 120 of the 200 words surveyed being identical

(*Basic situations about Gongshan Derung and Nu Autonomous County [Gongshan Dulongzu Nuzu Zizhixian Gaikuang],* p. 26, *Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 2, p. 17, Sun 1981). Culturally, the Anu, the Anung and the Derung have similar legends about how the world was created and similar kinship terms and marriage systems (L. He 2011). Historically, the self-reported migration routes of the Anu and the Anung coincide with those of the Derung in the early migration stages (L. He 2011). In addition, Anu, Anung, and a fraction of Nusu people share stories that some of them climbed over the Kaolikung mountain range, and became the "Qiu" (Derung) (Hong 1992). In Derung legends, their ancestors came from "Han people's place": two brothers arrived in the Nu River Valley and wanted to go to the Derung River Valley. The younger brother crossed the Nu River using a zip line. Before the elder brother could also cross, lightning struck and cut the zip line. After that, descendants of the younger brother lived in the Derung Valley and became known as "Qiu" people, while descendants of the elder brother lived in the Nu Valley and became Nung people (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 1-2). Based on these similarities, some scholars suggested that the Anu and the Anung within the Nung should be unified with the Derung in the same nationality (Editing Committee for A Compilation of Yunnan Minority Nationality Society and History Survey Data, 1987, p. 48-49). This suggestion was not adopted, because the Derung and the Nung had always been treated as two different groups by previous governors and other by ethnic groups, and the two groups recognized themselves as separate.

There are, however, two Derung clans, Jiangle and Longwu, with legends about migrating to the upstream Derung region from Chawalong, a Tibetan-occupied town upstream from Gongshan County along the Nu River (*Derung Society and History*

Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)], p. 31-32). They and the Mulang clan in Chawalong believe they came from the same ancestor. According to their legends, the ancestors of Jiangle and Longwu climbed over the mountains and reached the Derung Valley when hunting. They saw the forests were dense and the land was flat, so they left barley seeds on the ground. The next year, they came back to the region and found the barley to have grown well. Such legends suggest that the Chinese Derung might have multiple origins.

The Rawang (also known as "Riwang" or "Rvwang") in Myanmar is largely believed to be the same ethnicity as the Derung in China (Morse and Morse 1966, *Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 43). The Rawang mainly live along N Mai Kha River (the name of Derung River in Myanmar) and Mali Kha River in Kachin State in northern Myanmar. They speak languages related to Derung and were recognized as one of the six linguistic tribes in Kachin by the Myanmar government in 1962. The three main subgroups composing Rawang people are the Rawang, the Daru, and the Anung. A small number of Nusu who migrated to Myanmar mostly after 1950s were also granted the identity of Rawang. The Anung and the Nusu, as mentioned above, were grouped into the Nung and separated from the Derung in China. Myanmar Anung and Nusu, like Chinese Nung, do not recognize themselves as Derung or Rawang, and are now fighting to be recognized as a separate group parallel to Rawang, or as an umbrella group whose appropriate name, Nung, is used for all subgroups, including the Rawang (L. He 2011). The within-tribe variation of the Rawang is beyond the scope of this review, so I will only briefly mention that Daru and Rawang subgroups' languages are quite distinct and not mutually intelligible (Brown 1936; Leach 1954), and that the Daru have unique ironwork and distinctive female facial tattoo patterns (Morse and Morse 1966).

Myanmar Rawang people's close ties with the Chinese Derung are understood both by outsiders like historical governors and other ethnic groups interacting with them, and Derung and Rawang people themselves. Chinese Derung's historical exonym, "Qiu" or "Qiuzi", applied to both the Chinese Derung and the Myanmar Rawang living next to N Mai Kha (Derung) River downstream from the Chinese Derung (Xia 1908; Gros 2004). This region belonged to China and was under Qing dynasty's governance. In addition, Rawang people in Myanmar and Derung people in China share similar languages, folk religions (Guo 2010, p. 80) and life styles, and they recognize each other as kin (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 38, p. 209). Many Chinese informants have told me their clans have sub-branches that live in Myanmar now. In addition, Rawang people believe they migrated to their current residence regions from "the place of the rising sun", i.e., China.

Derung Language

There is consensus that Derung language is a Tibeto-Burman language, but scholars disagree about which branch it belongs to. Most researchers believe the Derung language belongs to the Jinghpaw branch (e.g., Sun 1981) , but Benedict (1972) suggested that the Derung language should belong to the Lolo-Burmese branch instead, although he also acknowledged the similarity between Derung and Kachin languages.

The Derung language does not have a writing system. Traditionally, Derung people marked woods and tied knots to represent items and numbers if they needed to keep records, and they used paintings and embroideries to express their thoughts and feelings (Editing committee for Basic situations about Gongshan Derung and Nu

Autonomous County 2008, p. 13). Three different writing systems were developed for the Derung people by missionaries and linguists in the 20th century, but none of them became widely accepted.

Upstream, midstream, and downstream Chinese Derung have different dialects. Before the man and horse walkway connected different villages in Derungjiang Xiang in the 1970's, there was relatively little interaction among them. As a matter of fact, the different Derung villages communicated with Tibetan, Nung, and Lisu people more than with each other (Tan 2017). This allowed the dialects in different Derung villages to diversify. Among the 1000 words surveyed in Sixiang (Bapo and Maku) and Sanxiang (Kongdang), 643 were the same and 138 pairs had phonetic corresponding relationships, while 191 pairs were completely different (Yunnan editing committee for Five Books on nationality issues and Editing committee for Chinese Minority Nationalities' Societies and Histories Survey Documents Series 1985a, p. 15). According to my informants, dialects in Dizhengdang and Longyuan are different from those in Kongdang. Chinese Derung villagers from different regions can still communicate but might have occasional misunderstandings because they use different terms.

Religions and Supernatural Beliefs

Traditional Derung folk religion

Derung people traditionally believed that every object and every individual had spirits. In this religious system, some of the supernatural spirits are good and some are bad. Other than the supernatural spirits, each individual has a living spirit. This living spirit usually follows the individual but may occasionally wander off. This is when bad supernatural spirits can hurt the person's living spirit and make the person's

body sick or create accidents. When the body dies, the living spirit then becomes a dead spirit, which goes to the dead spirits' place and lives there for as long as the person lived on earth. When the dead spirit's time is up, it then becomes a butterfly and flies back to the living world. Once the butterfly dies, the individual's journey is finished (Zhao 2014).

"Nanmusas" were one of the two forms of shamans in the traditional Derung folk religion, and they played a critical role in the Derung life. "Nanmu" meant "sky" in the Derung language and was extended to mean "supernatural spirits" in the phrase "Nanmusa". "Nanmusa" thus meant "spirits' representative". Nanmusas were believed to have spiritual eyes that could see things other people could not. A person became a Nanmusa after getting signals from a Nanmu. The person would first see supernatural scenes, and after the scenes continued for some time, the Nanmu(s) behind them would visit the person in its/their true form(s). At this time, the person had to accept the Nanmu(s)' invitation to be its/their friends. Otherwise, he or she would encounter misfortunes or illnesses. After accepting the invitation, the person became a Nanmusa. He or she would then serve alcohol to worship their Nanmu(s) at home, thus declaring their Nanmusa identity to the village (Cai 1998, p. 121). Nanmusas were usually outstanding individuals in the village, who were smarter, more productive, more attentive to Derung culture and history, and sometimes better at singing (p. 123).

Because they were believed to have supernatural abilities, Nanmusas had critical responsibilities, including 1) organizing "Kachangwa", the Derung New Year's festival, where people worshiped their clan or patriline's spirits; 2) directing production, e.g., giving advice on whether a plot of land is suitable for farming and holding spirit worshiping rituals before developing new swiddens; 3) holding rituals related to health, including lifesaving rituals for weak or sick people, and spirit recalling rituals for

people who died unnaturally; and 4) holding funerals for all deaths. During the rituals, Nanmusas would speak in tongues, which no other individual could understand. An informant told me that a Nanmusa usually served his or her own village, but if a neighboring village did not have a Nanmusa of its own, or if the Nanmusa was believed to be especially powerful, he/she might be invited to solve issues for people in other villages.

Traditional Derung folk religion declined in importance between the 1960s to the 1980s. This was a natural consequence of the Derung being integrated into the PRC's new political system. As they tried to direct village life in the traditional way, Nanmusas unintentionally acted as a barrier to the government's communist reformation and inevitably became marginalized in the new village politics. Their traditional knowledge was deemed to be false and their attempts to preserve traditional Derung practices were deemed to hinder the communist reformation movement, for example, when they told the agricultural production cooperatives some land pieces were unsuitable for farming and when they protested not being given enough food in the agricultural production cooperatives (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* pp. 103, 105).

Derung folk religion revived in the 1980s after the government drew back from organizing people's lives. However, even after its revival, the traditional Derung religion lost the central role it previously held in the Derung village life (Guo 2010, pp. 235-245). Both people's opinions and their objective circumstances changed. Due to the government's information campaign, most started to believe that the traditional Derung folk religion was a form of "misbelief". At the same time, Derung individuals gained much better access to modern medical treatments and better insurance against misfortunes since the 1980s, because of the government's support. Consequently,

"Nanmusas"' curing power was no longer critical. They are, however, still feared by some and respected by most, as people believe Nanmusas can cause misfortunes and illnesses (Guo 2010, p. 244).

Baptist Protestantism

Currently, the dominant religion among the Chinese Derung is Baptist Protestantism (Yan, field observation). It was first introduced to the Derung by American missionaries around 1935 (Y. Yang 2017). The missionaries visited many villages in the Derung Valley, but Baptist Protestantism was only accepted in Maku and Bapo. The mission with midstream and upstream Derung was unsuccessful because Lamaist churches had greater powers there and the people valued their own traditions and found Baptist teachings incompatible with their traditions (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* pp. 146, 157). For example, people in Xianjiudang rejected Baptist Protestantism because they thought it was unreasonable that God did not allow them to enjoy alcohol made from crops that they worked hard to produce (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 84). In 1999, there was a second expansion of Baptist Protestantism. Missionaries from Bapo visited Kongdang, Xianjiudang, Longyuan, and Dizhengdang, and successfully recruited Baptist followers in each administrative village.

The spread of Baptist Protestantism into Derungjiang Xiang greatly changed the lifestyle and ideologies of its believers. Baptist Protestantism does not allow its believers to drink alcohol, smoke cigarettes, or perform Derung folk religion rituals. It offers a new cooperative network in addition to the kinship-based traditional network. In Bapo and Maku, it also contributed to the falling decline of matrilineal cross-cousin marriage (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha*

(Er)], p. 158). However, it is hard to tell whether these changes were the results of Baptist doctrine, or a wish to make such changes led to the spread of Baptist doctrine. Chinese Derung people, especially those upstream and midstream, selectively adopted Baptist teachings and decided to convert or quit based on practical considerations. The American missionaries tried to arrange marriages for people in Bapo and Maku and claimed that Baptists were not allowed to marry non-believers. This rule was not followed after they left. In addition, Baptist Protestantism prohibits sex before marriage, but upstream Derung still largely follow their custom that a marriage is only official and in need of a government-issued certificate after a child is conceived. During my 2018 survey in Dizhengdang, most subjects reported that they converted to Baptist Protestantism so that they could quit drinking and smoking and thus save money, stay healthy, and stay away from misbehaving alcoholics. Some reported they converted so they did not have to waste chickens and pigs on Nanmusa rituals. Among the non-believers and the quitters, their reasons for not converting or quitting were mainly 1) they felt it was a waste of time that people had to rest on Sundays, and 2) they could not quit drinking and smoking.

Supernatural Beliefs

Under the influence of their folk religion, the Derung have many traditional mysterious beliefs and taboos. Summarizing the literature (*Basic situations about Gongshan Derung and Nu Autonomous County [Gongshan Dulongzu Nuzu Zizhixian Gaikuang],* pp. 22, 83; *Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 8, 31, 53) and my field experience, I offer a list below.

1) Land plots the Nanmusa deemed occupied by ghosts cannot be used for farming.

2) Outsiders are not allowed to visit a household if the household has members

going out to hunt or plant, otherwise the hunting or farming would be fruitless because the outsiders' souls can take prey and harvests away.

3) Seeds saved for next year's farming cannot be brought into the house, otherwise, they will not grow.

4) When cutting and burning forests for farming, people have to first worship the spirits under the leadership of their family community heads, otherwise crops will not grow.

5) After spirit worshiping rituals, family community members should cut down the trees and bamboo, select several and order them in a pattern on the ground. If the trees or bamboo stay in this pattern the next day, it indicates good luck and the farming begins; otherwise, people abandon that land and search for another plot.

6) Feces is dirty and brings bad fortune. If someone defecates on a piece of farming land, the land has to be abandoned.

7) If people see snakes when working, they have to return home immediately. Research records and informants disagree on the consequences and applications of this taboo. Some say seeing snakes and not returning will lead to more snakes appearing, while others claim misfortunes will happen to the witness and their families. Some researchers and informants claim that this taboo applies to big snakes, while some claim that it applies to seeing multiple snakes sequentially. There are also informants who claim that it only applies to seeing multiple snakes together.

8) A man cannot go hunting when his wife is pregnant, otherwise it will upset the mountain gods, and the man will have no luck in future hunting.

9) A woman cannot give birth in her parents' household, otherwise, the offspring will not prosper. If such cases occur, the woman's parents have to compensate their son-in-law with alcohol, meat, etc.

10) Birth giving can only occur outdoors, otherwise, the crossbows and arrows hung inside will get polluted and future hunting will go in vain. 11) No one in the same or nearby villages should work on their farming land within three days after a person dies. Otherwise, the person will run into evil spirits and get sick, and the crops will not grow.

From this list, we can see that most taboos are aimed at ensuring production yield and avoiding personal misfortunes like sickness and death. This might have resulted from the Derung people's lack of control over their environments in the past. Nowadays, most of the taboos are extremely loose, especially in the downstream region that has been under Christian influence for almost a century. Even in Dizhengdang, the administrative village where Derung traditions are best preserved, most people do not follow these taboos very faithfully. Some young people have not even heard of these beliefs.

Derung Customary Law

Traditional Derung customary law mainly focused on three domains: marriage, property, and violence. Customary law about marriage was mostly about bride price and children's belongings. Bride price customs were already introduced in the section "marriage". As to children, illegitimate children that a woman had before her marriage can be brought to her husband's household, and they would be treated just like the couple's own children. If a couple got divorced after having children, they split the children (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)]*, p. 88; Yan, field data). If they had multiple children of both sexes, the husband and the wife would split their children by sex and age evenly. It was as if the husband and the wife took turns in claiming children of the same sex from eldest to youngest.

For example, the husband would take the oldest son, the wife would take the second oldest son, and then the husband would take the third oldest son and so on. The same went for their daughters. If the couple only had one son and one daughter, the son would live with his father and the daughter would live with her mother. If the couple had only one child, the child belonged to the father regardless of the child's sex, unless the child was still nursing. Divorce rarely happened in traditional Derung societies and is still uncommon in modern within-Derung marriages. These rules about child custody are still in practice. In addition, Derung customary law specified that when a wife cheated on her husband, her lover had to give the husband items as compensation for his shame, known as "face-washing money".

The Derung had detailed rules on ownership identification and ownership protection of property. To announce ownership of one's own items or newly found items, Derung would mark the items with knife cuts, or put branches or stones on the items (Xu 2011; *Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 81). Others thus knew the items had owners and would not take them. To announce ownership of a selected piece of land, people could either cut some trees or grass down, cross two pieces of bamboo and stick them to the ground, or select a few trees on the edge of the land, remove the bark, and left cross or zigzag knife marks on the exposed tree trunk, or select a few trees on the edge of the land and cut off all the branches. Others thus knew that piece of land was already taken and would look for other pieces instead.

Stealing, especially of food, was the most severely punished crime in traditional Derung societies. A thief could receive the death penalty. There were only two cases of stealing in the Derung oral history (Xu 2011). In one case, the thief was sentenced to be beaten to death in front of all the villagers. In the other case, people judged

that the thief should give his daughter to the victim as a slave. Nowadays, such severe punishments are banned by the PRC government, but stealing is still one of the most condemned behaviors in Derung villages (Yan, field data).

The penalty for violence was relatively mild in comparison. When people from different family communities engaged in fights and hurt or killed one another, the more severely hurt party could ask for material compensation for their wounds or mortality. If the damage was mild, they would receive several buckets of alcohol; if the damage was severe, they would receive a pig, a cow, or an iron pan. When death happened, they could ask the killer to compensate 9 types of items, 9 pieces of each type. If the death happened during fights between two family communities, the aggressor's family community took it upon the whole community to compensate the victim's family community. Otherwise, it was the responsibility of the aggressor himself/herself and his/her close kin (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 9). After the compensation was made, the two parties had to agree not to hold any grudge. Sometimes the judges would treat the two parties to food and drinks to encourage them to make up. When rape happened, the man had to pay the woman her choice of items, like a cow, an iron pan, or a piece of blanket. The compensation for rape was also called "face-washing money". Like how a man had to pay the husband for cheating with hiser wife, this compensation was also to make up for the shame the wrongdoer brought to the victim (Wang and Gao, n.d.; Xu 2011).

Derung people judged whether a wrong behavior actually happened through either a human trial or a god trial. In a human trial, a judge, usually the leader of the family community, known as "Kasang", or if the matter involved more than one family communities, both the "Kasangs" and the "Kasang" from a third neutral family community when people felt necessary, would serve as the judges. The plaintiff and

defendant would then list their reasons or evidence. For each reason or piece of evidence presented, the judge(s) would put a corn kernel or a piece of bamboo in front of the person it favored. In the end, whoever had more in front of them was judged to win. In god trial, the prosecutor would provide a pan, boil water and throw into the water a stone, and the defendant was asked to take the stone from the pan with bare hands. If the defendant could do it without hurting his/her hands, he/she was judged to win and could take the pan and some additional agreed-upon items, like a pig or a knife. Otherwise, the plaintiff was judged to win and the defendant had to face punishments according to the charge (Wang and Gao, n.d.).

Derung Clans, Family Communities, and Households

To understand how norms change and linking such group-level patterns to the individual-level normative behaviors and attitudes, we must first identify who make the normative decisions and to what degree. We can then measure these agents' normative behaviors and attitudes, quantify the ecological and social payoffs they would receive from each normative behavioral option, and predict whether and how their behaviors and attitudes would change, and whether such changes would persist or spread. Nowadays, the agent that makes decisions about subsistence crop farming is each individual household. One or more members in a household may offer inputs on what to farm, whether to co-farm, who to co-farm with, and what division offers to make. This, however, has not always been the case. In this section, I introduce the productive and diplomatic unit in Derung life at different periods.

A clan is the highest level of Derung social units, but there is no information on what role they played in Derung life. is There are 15 clans along the Derung River in Dizhengdang, Longyuan, Xianjiudang, Kongdang, and Bapo (*Basic situations about*

Gongshan Derung and Nu Autonomous County [Gongshan Dulongzu Nuzu Zizhixian Gaikuang], p. 76, *Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 23) (Data from Maku is missing). Each clan is composed of the descendants of one man who migrated to the Derung Valley. The names of these clans usually indicate good fortune and virtue, like "born from heaven", "good at adapting", etc. (Yunnan editing committee for Five Books on nationality issues and Editing committee for Chinese Minority Nationalities' Societies and Histories Survey Documents Series 1985a, p. 54). Informants from the 1950s could not recall living or producing in whole clan units. Other than feeling closer when meeting each other, and visiting each other during wintertime (Yunnan editing committee for Five Books on nationality issues and Editing committee for Chinese Minority Nationalities' Societies and Histories Survey Documents Series 1985b, p. 21), individuals from the same clan but different family communities interacted the same as individuals from different clans.

Among the Derung before 1900, family communities were the basic social units in which people lived, produced and conducted diplomacy. The 15 clans mentioned above included 54 family communities. The family communities' names usually came from their residence locations but stayed with the people even when they moved. Each family community was composed of one man's descendants and their wives. Usually, each family community formed a village, but two or three family communities might also live in close proximity. A village could also have people from more than one family community when a new couple stayed with the woman's family. Family communities owned forests, farming lands, and fishing plots. Before 1900, members in the same family community mostly worked together and divided game and crops among themselves (Yunnan editing committee for Five Books on nationality issues and

Editing committee for Chinese Minority Nationalities' Societies and Histories Survey Documents Series 1985a, p. 25). Each family community had a head, called "Kasang", meaning a person good at talking. This person organized subsistence activities, like deciding when the family community sowed, gathered, or hunted together. They also resolved conflicts within the community and acted as representatives in interactions with other family communities (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 41). The position of "Kasang" was not inherited and had to be earned through personal virtues. In the 1950s, however, sons of the old "Kasang"s were more and more likely to become the new "Kasang"s (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 39). The "Kasang"s from different family communities were equal. The only exception was when some were appointed as administrative village leaders by Kuomintang and started directing other "Kasang"s and other family communities.

Between 1900 and 1950, households gradually replaced family communities as the basic social unit. During this time, the typical household size and composition also changed. Before 1932, the most common composition of a household was an extended family with three or four generations (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 18). An old couple, the old couple's sons and their wives and sons, and the old couple's unmarried daughters lived together. When a son got married, the newlyweds would set up another fireplace in the house and separate an area around the new fireplace to use as their room (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 54). Within a household, the eldest and most senior male was the natural leader, but he was by no means a dictator. Matters were usually settled through household-wide discussions (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],*

p. 5). Even small decisions like purchasing a piglet had to be supported by the whole household (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 119). The household leader may have done less work than everyone else, but he still had to work.

Among nuclear families within a household, equity was the rule and was reflected in the division of farming returns and delicacies, and in sharing workloads. Members of the same household farmed together. Some of the gains would be stored in the public storage room. The rest would be divided equally among the nuclear families and stored in their individual storage rooms, no matter how many laborers or dependents each nuclear family had (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 118). Wives of the young generation took turns in cooking. Food was first taken out from the household public storage room. When it ran out, each wife took food from her nuclear family's individual storage room when it was her turn to cook (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 42). Because nuclear families had started to conduct independent farming and cooperative farming with partners outside the extended family by the 1950s, the nuclear families in an extended family household may have had different amounts of crops stored. In this case, the nuclear families with additional food would continue to feed the whole household (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 42; *Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 23). When a household received delicacies, the distribution was equal by person instead of by nuclear family. Each person, including children, received an equal share. Disputes seldom arose within households (Vol. 2, p. 119). This "fairness means equity" philosophy is also reflected in the Derung co-farming division norm to be analyzed in detail in the next chapter.

From 1900 to 1950, Derung households gradually shifted from extended families to nuclear families. Even in Bapo and Maku, where extended family households were more common than in other villages, only 16% of the households were of extended families in the 1950s (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 55). After the shift, each son, except the youngest who was the inheritor of the house and the caretaker of the parents, would build a new house after getting married. The brothers' nuclear families may still conduct production together. They could also work on their own or form cooperative partnerships with other kin or friends. In 1932, an average household had 14 individuals. In 1957, this number varied from 6.1 to 7.6 in different administrative villages (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 13). The change in household composition was motivated by economic, cultural, and political factors. Economically, as the tools and technologies for production developed through the first half of the 20th century, big production units became less and less necessary, so the power of family communities and extended households became weaker and weaker. Cooperation in production shifted from kin-based to location-based. Newly established nuclear families thus had the opportunity to move and select their own cooperative partners. Culturally, after XIA Hu's visits, the Derung people were increasingly influenced by Han and Lisu people and adopted the custom that sons should go out and establish a new household after getting married (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 13, p. 42). Politically, sometime between 1912 and 1949, Kuomintang (the party leading the Republic of China) asked Derung extended families to split to increase household-based tax income (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 42).

From the 1950s to today, the average household size decreased further. In 2019,

the average size of households in village D was 3.1 (Yan, field data). This is partly due to increased access to modern tools and technologies, which has enabled production in even smaller units, and partly due to the insurance the PRC government provides to Chinese Derung people, which has decreased their dependence on support from kin. In addition, the government's "family planning" policy started in Gongshan County in the 1970s and gradually increased in intensity. According to this policy, each Derung couple is allowed 3 children (Zheng Xin-zhe, 2017, p. 154-155). If they want more, they have to pay a fine for each additional one. The amount of the fine is considerable relative to their income and has effectively suppressed their birth rate.

Marriage

Kin selection is an important mechanism for cooperation, of which cooperative farming is an example. When asked about kinship with another villager, a Derung person often answers "we are all kin here" if there is no clear trackable relation between them. While sharing a common ancestor connects Derung people in the same family community, Derung marriages connect all family communities by creating a unilateral circle along which women from different family communities move.

Traditionally, the Derung performed within-group matrilateral cross-cousin marriage. The preferred form of marriage was between a man and his mother's brother's daughter(s) (Chen 2019). Such matrilineal cross-cousin marriage was commonly seen among Tibeto-Burmese people (Leach 1954). Although the relatedness between a husband and his wife would be the same in other forms of first-cousin marriages, these were forbidden. A man and his father's brother's daughter or his mother's sister' daughter inherited the same paternal or maternal bloodline and were seen as siblings, so marriage between them was seen as incest. Although a man and his father's sister's

daughter were first cousins with different bloodlines, their marriage was thought to be in the "wrong direction". As explained by an informant, "Derung River can only run from north to south. It cannot go the other way from south to north. Otherwise there will be floods and people will all die" (Sang 2017). When there was no mother's brother's daughter suitable for a Derung male to marry, he would consider his mother's paternal cousins' daughters. If there was again no suitable girl, he could look in the secondary-choice or third-choice marriage partner family community. The preference for unilateral matrilineal cross-cousin marriage thus led to a unilateral exchange of females among the family communities. Through the exchange of females, the different nuclear families, different family communities, and different clans became connected (Chen 2019). This marriage rule was strictly followed. Unless there was no such male or all males fitting the above specification gave up their rights to marry her, a Derung girl could not marry other men. Otherwise, she would be frowned upon by other villagers (Chen 2019). Many young couples that were committed to each other but had to separate because their parents were to marry them to their cross-cousins committed suicide so that they could stay together in the afterlife (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 87).

Nowadays, this marriage rule is no longer enforced among the Chinese Derung (Sang 2017). There is no record of when this change happened, but based on my field observations, the Derung marriage norms are abandoned more thoroughly in Bapo and Maku than in Dizhengdang and Longyuan, probably because Bapo and Maku received Christian influences much earlier. The within-group marriage rule is also abandoned. Derung girls now more and more frequently marry Lisu, Nung, Tibetan, or Han people out in the Nu Valley or even farther regions. Occasionally, women and men from these ethnic groups also marry into Derungjiang Xiang. From 1999 to

2010, 35% of the newly established marriages in Dizhengdang were between a Derung and a partner from another ethnic group (Sang 2017). The matrilineal cross-cousin marriage rule also lost its power. Today's young Chinese Derung people select their own partners, and even if their parents do not think much of the person, as long as the young couple insists, the parents always eventually agree. However, the belief that tabooed marriages, like the marriage between a man and his father's sister's daughter, will lead to bad fortunes for the couple and their children, still exists in Dizhengdang villagers' minds (Sang 2017).

In the past, to marry a girl, the male's family had to pay a bride price to her family. After that, the girl became her husband's family's property. However, he was still obligated to help his in-laws with labor work and to bring gifts to them when visiting. Marriage rituals were optional (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 56). If a woman wanted to cancel the marriage or wanted a divorce, or if she died soon after the marriage due to no fault of the man, then either one of her sisters had to marry the man, or her family had to return all the bride price *Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 45. If it was the man who wanted a divorce and if the woman had not made any big mistake, like cheating on him, some informants said half of the bride price had to be returned, while some claimed the girl's family could keep all the original bride price *Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 88. If a man killed his wife or pressed her to kill herself, he would not get punished, since his wife was his family's property. For the same reason, if a Derung woman's husband died, she had to marry the dead husband's brother, father, paternal cousin or uncle, or other paternal male kin, even if they already had wives. If nobody in the family community could take her, which was rarely the case,

she could marry into other family communities. Some informants claimed that her parents had to return the bride price to her previous husband's family in that case *Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 45, but others claimed it would be the dead husband's family that asked her new husband to pay a bride price, usually half of the price of marrying a never-wed girl. As marriage became the young people's own choices, bride price and norms about bride price have largely disappeared from Derung life.

Monogamy was the most common form of traditional Derung marriage (Liu 2006), but polygyny also existed. Some polygynous marriages resulted from a woman getting remarried to a man in her husband's family after he died. In other cases, wealthy family community leaders or household heads married multiple women. This phenomenon appeared no earlier than two generations before the 1950s *Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 46. The senior wife's younger sisters were natural first choices, but the man could also marry other women after gaining the senior wife's permission. The main aim of marrying multiple wives was to increase the number of laborers in the household. The family community leaders or household heads basically used their junior wives as servants to reduce their own workload *Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 46. The PRC government's marriage law does not allow for polygyny, so currently monogamy is the only form of marriage in the Chinese Derung.

Subsistence modes and division norms

Derung subsistence modes include swidden horticulture, hunting, fishing, honey collecting, gathering and livestock rearing. This same subsistence system persisted from the first records of Derung lifestyle to the present, although the importance and

scale of different activities have changed. There were and still are no professionals specializing in only one trade among Chinese Derung villagers. Even the individuals with administrative positions farm and gather. Farming is the context I focus on to study individual norm decision-making and norm evolutionary dynamics. It will be discussed in depth in the next section. In this section, I give a brief overview of Derung hunting, gathering, livestock rearing, and the cooperative production division rules for each activity, with cooperative production defined as multiple units (individual or household) that do not consume the products working together to generate the products.

Hunting

Prey animals for the Derung included black bears, monkeys, forest rats, bharals, musk deers, muntjacs, wild cows, wild chickens, sparrows, etc. Most of these animals have been listed as protected animals and hunting them is banned by the PRC government. However, forest rats and sparrows are still legally available for hunting. Other than consuming meat, Derung people use animal parts as medicines to treat illnesses. For example, wild cow horns are used to treat fever, and bear fat is used to treat insect bites (Yan, field observation). Whether such treatments are effective is a question yet to be answered. Traditionally, animal products, like rock sheep skin, were also used to pay taxes and tributes to the local chiefs and Lamaist churches.

Derung people used either crossbows and arrows or bamboo snares to acquire game. The arrowheads were made of iron or hard-textured bamboo. Derung people used plain arrows to kill small game and applied poison on the arrowheads to hunt larger ones. Snares were composed of sharpened bamboo, a motion activator, and a string attaching the bamboo to the motion activator. The string would release the

sharpened bamboo once an animal steps on the motion activator. The placement of the snare depends on the target prey. For example, if a hunter wants to kill a bear, he will set the trap next to honeybee hives.

Traditionally, Derung hunting was mainly performed during wintertime. Hunting in the summer was informal and only targeted bears and monkeys that came to people's farming land to steal crops. Hunting of small game could be carried out by individual hunters, while big game required larger groups. If hunting was performed by a group, the prey would be divided equally among the participants, except for the head, the skin, and one hind leg, which belonged to the person who first shot the animal (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 4, 22, 97). This division rule was the same in all Chinese Derung regions. People who participated in hunting and received meat were then supposed to share it with households that did not participate (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 97).

Gathering

The Derung gather subsistence plants and medicinal plants. Gathering subsistence plants was the most important form of subsistence activity before the 1930's: it took up two thirds of all time spent on production (Editing committee for Derung Society and History Survey: Vol. 1, 2017, p. 21). Over the first half of the 20th century, the importance of subsistence plant gathering in Derung life decreased. According to some informants, this was maize was introduced to the Derung sometime between 1900 and 1932, and potatoes were introduced in 1932 (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 21). These crops made farming more productive and allowed it to replace gathering as the most important

subsistence activity. Nowadays, although Derung people can rely completely on farmed and purchased food items, they still gather subsistence plants, including lilies, kudzu, bamboo shoots, mushrooms, and a variety of vegetables, to diversify their diet.

Medical plants that the Derung gather include Chonglou (paridis rhizoma), Beimu (fritillary bulb), Huangjingguo (polygonatum sibiricum), Chongcao (cordyceps), Huanglian (coptis chinensis), etc. In the past, the Derung people used these items to pay tributes to the local chiefs and Lamaism churches. They also used them to trade with the Nung, Lisu, and Tibetan people for goods like salt and farming tools. Nowadays, gathering medical plants is an important source of cash income for Chinese Derung people, especially for people in Dizhengdang and Longyuan, where Caoguo (Tsaoko), a highly profitable cash crop introduced to the Derung by the PRC government in 2014, whose fruits are frequently used in the making of meat dishes to remove the smell of blood, does not grow well .

Before 1900, the gathering of either subsistence or medical plants was mainly performed by whole family communities under the "Kasang"'s organization. The gathered items would then be divided equally among all households within the family community. Even those who did not successfully gather anything would receive an equal share (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 21). Over the first half of the 20th century, the gathering units gradually shifted from family communities to individual households.

Livestock rearing

Livestock rearing was not a big part of traditional Derung subsistence. Records from the Republic of China (1912-1949) claim, "[Derung people] do not know what livestock rearing means. They have few chickens and pigs, let alone horses and cows." In the

1950s, many households had chickens or pigs, and a few had cows, but no horses or goats (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)]*, p. 4). Traditionally, chickens and pigs were mainly consumed for religious rituals (introduced in the section "Traditional Derung folk religion").

Nowadays (Yan, field observation), almost all the households in Dizhengdang village rear chickens and pigs. The number of chickens in a household varies from four or five to 20-30, while the number of pigs is usually one to three. Both Derung chickens and Derung pigs take around a year to mature. Since 2018, the PCR government has been distributing fast-growing chickens and chicken-rearing necessities (water feeder, meal feeder, chicken feed) to Chinese Derung villagers, but only about 40% of them survive to consumption. Many Derung households own cows. The most common breed is the Derung cow that only exists in Derungjiang Xiang. They live in fenced mountain ranges used as village pastures and only come back to the village for salt. Dizhengdang villagers rarely sell their cows, probably because the downstream Chinese Derung villages have a more developed livestock-rearing industry and already control the market. They also rarely eat the cows. The cows thus either die of old age or from accidents, like falling down cliffs. The main motivation for cow rearing reported by the informants from Dizhengdang is that the PRC government issues subsidies for each living Derung cow, to preserve the breed. Only a small number of the households in Dizhengdang (3 out of the 60 interviewed in 2018) rear goats. The goats forage on their own and occasionally feed on other villagers' crops, in which case their owners have to compensate for the crop owners' damage with money or goat meat. The Derung do not milk their livestock.

Derung Farming

Derung farming has been changing from about 1750 to the present. The Derung may have performed farming before 1750, but that is the date of the earliest historical records. The changes occurred in every aspect of farming. The Derung originally practiced basic swidden horticulture, and then invented alder swidden horticulture where they planted alders (Alnus nepalensis) to burn, then shifted to a system with small pieces of fixed land, and finally settled at pure fixed-land farming with the PRC government's promotion. Land originally belonged to family communities, then to partner households, and finally to individual households. The Derung originally used bamboo, wood, and stone tools, and then borrowed iron tools of different forms from the Nung, Tibetan, and Myanmar people. Then in around 2010, the market brought gasoline-fueled motorized tools. Derung began with simple slash and burn, shifted to artificial cultivation of trees; then started to use oxen and to grow paddy fields, and later incorporated the use of fertilizers and plastic land films. Derung originally only had subsistence crops that grew on dry land. They received rice in 1952, later quit farming rice in many regions, and then started receiving multiple kinds of cash crops in 2010. In this section, I will introduce the evolution of Derung farming chronologically. Because the PRC government played a major role, I divide the phases according to government policies and actions.

Traditional Derung farming before 1950

Derung farming was first documented by Qing officials (Fu and Dong 1763). Before 1950, the Derung crops included maize, potatoes, barley, wheat, buckwheat, tartary buckwheat, and multiple varieties of millet. Among these, the history of maize and potatoes was the shortest. Maize entered Derungjiang Xiang sometime between

1900 and 1932, while potatoes entered in 1932. When government-organized survey teams entered in the 1950s, Derung farming was starting to transition from swidden horticulture to fixed land farming; the most common farming unit had transitioned from whole family communities or partner households to single households; private ownership of land also started to appear. In this sub-section, I introduce Derung farming as observed by the survey team in the 1950s. Information about Derung farming before that was recalled by the informants surveyed in the 1950s.

Basic swidden horticulture

Basic swidden horticulture was the most traditional form of farming for the Derung. It was the only mode of Derung farming before alder swidden horticulture was invented and was still the most common form in the 1950s. In Kongdang in 1956, basic swidden horticulture took up 49.7% (346 Mu) of the total 696 Mu[4] of dry farming land (Yunnan editing committee for Five Books on nationality issues and Editing committee for Chinese Minority Nationalities' Societies and Histories Survey Documents Series 1985a, p. 27-31). In Longgun (a family community in Longyuan) in 1960, it took up 75.9% (141.8 Mu) of the total 186.8 Mu of land (Yunnan editing committee for Five Books on nationality issues and Editing committee for Chinese Minority Nationalities' Societies and Histories Survey Documents Series 1985b, p. 57). In this form of farming, Derung people would select a piece of forest, cut down the trees, burn them to provide fertilizer, and farm a mix of crops in a mixture on the swidden. Usually, each land plot was abandoned after one year of farming and was only reused after 4-7 years (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 26, 49, 59), when the trees grew back and could be burned to once again to provide nutrients.

[4]Mu is a Chinese area measurement. Each Mu is roughly equal to 666.67 square meters.

Occasionally, the land was farmed for a second year, but then people had to clear the grass and loosen the soil for the second year's farming. This option was seldom chosen because such work was difficult with traditional Derung farming tools. As the number of times a piece of land had been burned and farmed on increased, the yield decreased, and the resting period extended. This is because the tree roots were less and less able to grow new branches and the soil became depleted (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 50). The longest resting period could be 15 years or more.

Swidden horticulture requires rotation of land. Derung family communities' residence location had to change within their home range based on land availability. To plan land usage, family communities divided their forests into different sections and divided each section into different plots. They would start with one plot in one section and move to another plot in the same section the next year. After all plots in a section had been farmed 3-5 times and overexploited, the whole family community would move to another section together and farm there (Lu, n.d.).

Originally, whole family communities were the production units for basic swidden horticulture, but over the first half of the 20th century, it became more common for a subset of the members to farm together. In the 1956 survey on Kongdang farming, within the 346 Mu of basic swidden, only 30 Mu was farmed by whole family communities (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 27). Most of the basic swidden was farmed by cooperative farming partner households , while 22 Mu was farmed by individual households (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 27-31). Because mountains and forests were owned by the whole family community, if some members wanted to take a piece of land and farm on their own, they had to receive the

permission of the whole family community. This rule, however, was seldom enforced in the 1950s unless the land to be taken was a recently cleared swidden that had only gone through one or two rounds of farming or was an abandoned swidden plot that was in a larger, flat area. Individuals from other family communities may farm in mountains out of their home range after receiving permission from the owner family community. Another mechanism to access other family communities' land was to join the cooperative farming groups from that family community.

Alder swidden horticulture

A more productive advanced version of swidden horticulture, which I will call alder swidden horticulture, involved planting alders to speed up the land rotation in swidden horticulture. Alders (Fig. 10) have soft, medium-density wood and are easy to cut down and fast-growing. They also fix nitrogen (Gros 2014). These properties make them perfect for land fertility preservation. Instead of waiting for 5-7, or even 15 years for trees to grow naturally after farming for one year, with alder swidden horticulture, Derung only had to rest the land for 2 years after 3 years of farming. On swiddens that had already been farmed for several rounds, Derung farmers would plant alders and then on the same plots of land farm tartary buckwheat in the same year, millet in the next year, and maize in the year after that and abandon the land for 2 years (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 26). After the 2-year rest, the alders that had been growing for 5 years would reach six meters in height and could be cut down and burned to serve as fertilizer. The process of planting alders, farming for 3 years, and resting for 2 years could then be repeated. There did not seem to be a limit to how many times this process could be repeated. Other than increasing land availability, alder swidden horticulture produced twice

Figure 10. Cross-Section of a 6-Year-Old Alder Tree, with Yan's Left Fist for Scale

as much as basic swidden horticulture for a given area of land (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 55). Alder farming land plots were semi-fixed and indicated a transition from shifting cultivation to fixed cultivation.

Alder swidden horticulture was among the most important forms of Derung farming in the 1950s. It was reported to have been invented first in upstream Derung and then spread to Bapo and Maku in the 1880s. Due to less experience with this form of farming and having more available forest in which to conduct basic swidden horticulture, Bapo, and Maku had less alder swidden than Dizhengdang, Longyuan, Xianjiudang, and Kongdang. In upstream and midstream villages, Alder swidden horticulture and basic swidden were both popular in the 1950s. In Kongdang in 1956, 315 Mu (compared to 346 Mu of basic swidden) of the 696 Mu of dry farming land was of Alder swidden horticulture. In Xianjiudang in 1960, basic swidden took up 47%, alder swidden horticulture took up 45%, while garden land (introduced below)

took up 8% of all dry land (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 65). Alder swidden horticulture could be performed by cooperative farming groups or individual households. The division rules for Alder swidden cooperative farming were the same as for basic swidden cooperative farming in the same village. These rules will be introduced in subsection 6.

Fixed land

A third form of traditional Derung farming was fixed land farming. Only a small proportion of farming area was used for this form of agriculture in the 1950s. Fixed land included garden land and mature fields. Unlike swidden horticulture, fixed land farming does not require land rotation or burning trees and using the ashes as fertilizers. How the Derung maintained the fertility of their fixed land was not mentioned in the historical records. Derung only started to use feces[5] as fertilizers only during the government's agricultural production cooperatives during the 1950s. My educated guess is that they might have collected rotten leaves and used them as fertilizers for their fixed land, as this practice still is prevalent in contemporary Derungjiang Xiang. Garden plots were next to Derung people's houses, while mature fields were usually farther on flatter areas of the village. Another difference is that most mature land was farmed for 3-4 years and then left to rest for 1-2 years, while garden land was farmed every year. In some villages, mature land was also farmed every year. According to the informants, fixed land farming spread from Tibet to Dizhengdang and Longyuan, and then downstream to other Derung villages. Garden land farming started in Kongdang no earlier than 1920 and started in Bapo and Maku

[5]Ulthough it was unspecified, the feces the Derung used at this time was probably human feces instead of manure, because until 2000, Derung livestock roamed freely to forage on their own.

not long before 1957 (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 32). In the 1950s, Bapo and Maku still had no mature land. The Derung people grew potatoes, maize, millets, beans, peppers, and vegetables on their garden land and mature fields. Garden land yielded 1.5 times as much as Alder swidden horticulture, making it the most productive of the three forms. All garden land was privately owned and privately farmed. Even within a household, the different wives had their own garden plots (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 64).

Land ownership

Originally in the Derung farming history, all the land was owned by family communities. Starting from around 1850 (based on informant recalls), private ownership appeared (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 50, 81). From then to the 1950s, land ownership gradually shifted to units with fewer and fewer households. Although there were occasional reversions, for example when several households inherited the land together, the general pattern was set. In the 1950s, private ownership of land by single households was the dominant form of landholding, while only a negligible amount of community-owned land was still farmed by whole family communities (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 91). Privately owned land took up 69% of all land area in Xianjiudang (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 7).

Labor investments that increased future land productivity would grant individuals making the investment temporary ownership. The investment could be clearing dense forest for the first time, or planting alders. In basic swidden horticulture, land that

had been farmed once or twice was preferred, because the new tree branches were easy to cut down and the land was still highly fertile. Therefore, the people who first converted a piece of forest to farming land earned the claim to it for more rounds. After three rounds of farming, however, the initial investment in the land no longer mattered and anyone from the family that owned the forest could take the land if they wished (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 93). Growing alders, on the other hand, was an investment that could be renewed. No one else was allowed to use the plot of land when it was resting without the tree planters' permission, and there was also a consensus that original alder tree planters retained the right to plant alders again (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 70). In some villages, if the original tree planters did not continue to plant alder trees, others could take the land, whereas, in other villages, the original alder tree planters and their descendants had a permanent claim to the land even if it was left uncultivated (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 93). Growing alders continuously could thus establish long-term land ownership. Individual households or partner households could plant alder trees not only on forests owned by their family communities, but also on basic swidden plots that had been farmed for multiple rounds by a cooperative farming group they were a part of. For example, in the survey on Yixiang farming situations conducted in 1957, an individual acquired his three alder swidden plots by planting alders on basic swiddens previously owned by him and his 3 partner households (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 69).

Group-owned land could also turn into privately owned land when all but one of the households withdrew from cooperative farming. When a cooperative farming

group developed land from scratch for basic swidden horticulture or planted trees together for alder swidden horticulture, they gained co-ownership of the land. If some of these partner households wanted to withdraw, they could do so freely. The land, however, stayed with the households that did not withdraw, even if there was only one household remaining (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 27, 80-81). This rule discourages withdrawal from cooperative farming as people who withdraw from cooperative farming lose their investment.

Land trading appeared together with private ownership. By the 1950's all three forms of land had been traded, but trading of alder swidden plots was the most common (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 34, 70). Among the 31 land trading cases in a village with 17 households in Longyuan, 23 were with alder swidden, 5 were with basic swidden, and 3 were with garden land (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 70). In Kongdang, all 9 cases of land trading were with alder swidden (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 34). Land was exchanged for items like crops, iron knives, pigs, chickens, etc. There was no constant trading price, but the prices paid in these cases were all low compared to the land plots' value calculated from their yields (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 71). In the 1930's, a villager in Longyuan traded a plot of alder swidden that could yield 600kg of harvests (kind unspecified) every year for a piglet (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 71). The authors did not mention why they deemed this price-to-value ratio low. In addition, land trading required no witness, contract, or formal procedures (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 70; *Derung Society and History Survey: Vol.*

2 [Dulongzu Shehui Lishi Diaocha (Er)], p. 93). Therefore, in the 1950s, land trading was casual and still at an early stage (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 70; *Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 71).

The possibility of trading land created a third mechanism for turning group-owned land into privately owned land: trading of partial ownership among co-owners. For example, in Sixiang, two households converted a parcel of the community-owned forest into basic swidden and gained co-ownership of it. After one round of farming, one of the households faced starvation and transferred their partial ownership to the other household for 5 liters of corn (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 80). The land may still be farmed cooperatively by the original group, but now the household with full land ownership could take the land with them if they wished to withdraw. They could also decide to farm alone or with other households.

Farming tools

Before the PRC government distributed farming tools in 1952, the Chinese Derung used a combination of bamboo, wood, and iron tools. Iron tools were the most efficient but also the fewest in number. They spread to the Derung from Nung, Nakhi, Tibetan, and Myanmar people. On the contrary, wood hoes and bamboo or wood point-seeding sticks were traditional Derung farming technologies passed down from generation to generation (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 2). Derung people may have also used stone tools, but these never took on an important role in Derung farming. The forms of Derung farming tools were basic. As documented by XIA Hu (1908), "Their farming tools do not include

Figure 11. Derung "Knife"

plow or hoe. When they farm, they cut the trees down with knives and burned them. They use bamboo to drill holes in the ground, and 'point-seed' corn. If they farm buckwheat, wheat, etc., then they only spill the seeds on the ground and sweep them even with bamboo brooms. They let the seeds grow and fruit on their own, and they all do." The same farming procedures were still practiced in the 1950s. Contemporary Derung "knives" are long machete-like tools (Fig. 11).

There was no firm record of when iron farming tools first reached the Chinese Derung. According to informant recalls, iron cutting knives were the first to enter. When this happened, however, was ambiguous, with some claiming around 1750 (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 74; *Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 2) and others claiming around 1850 (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 20). Iron tools were much more efficient than the corresponding wood tools. For example, "Kyaka" and "Gela" were both hoes. The only difference was that "Kyaka" had a small piece of iron wrapped around the head, while "Gela", the traditional Derung hoe, was made of only wood. The iron head made a "Kyaka" 3 times as efficient as a "Gela". It could also be used to loosen

rocky land plots while a "Gela" would break (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 74). Although Derung people knew iron farming tools were superior, they did not use them very often before the 1950s, because they did not know how to produce iron, and had to trade with other ethnic groups at high prices to acquire them.

Division for labor and land contribution

When a family community farmed as a whole, gains were divided equally among all households. Under the "Kasang"'s direction, each household would contribute the same number of laborers and the same amount of seeds, and finish sowing together in one session. The gains were divided by elder women (and occasionally men) equally among all households in the community. The equal division by household rule was true for Chinese Derung in all regions when they performed community farming.

The division rules for cooperative farming among selectively formed partner households were different in different Chinese Derung villages (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 53, 71). Cooperative farming was second to single-household farming in popularity before the PRC government entered in 1950. It took up 25.5% and 27.1% of the farming land area in Longgun and Longyuan, two villages in the administrative village of Longyuan, and 24.2% in Xianjiudang (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 10). All the six administrative villages shared the principle that a household would not receive more in the division for land ownership, but they would for providing more seeds (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 64, 69). The rules for division based on differential labor contribution, however, varied. In upstream and midstream villages,

including Dizhengdang, Longyuan, Xianjiudang, and Kongdang, cooperative farming partner households usually contributed the same number of laborers, but occasionally contributed as many as possible (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 10). The gains were divided equally among the partner households regardless of labor contribution (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* pp. 53, 69). In downstream villages, including Bapo and Maku, the gains were divided in proportion to labor contribution (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 53). This applied even to cooperative farming among relatives. For example, in Bapo in 1956, one mother farmed together with her three sons. She participated by herself, while all the sons participated with their wives. The mother ended up earning half of a share, while the sons' households each earned a whole share.

A variation of this rule applied in Bapo and Maku when the cooperative farming partner households cut and burned the forests together from scratch. In this case, the second round of cooperative farming's division was based on labor contribution in the first round, when they cut and burned the forests, even if the relative number of laborers in the second round changed. This is because cutting down dense forests for the first time was labor-intensive, and increased land fertility for the first several rounds of farming. From the third or fourth round, division switched to being based on labor participation in that year (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 65).

Other than participating in cooperative farming and gaining a share of the yields, Derung could contribute to others' farming by lending their farming land plots or lending their labor. Such contribution, however, was under-compensated, if we compare

the Derung arrangements to sharecropping, land renting, or labor hiring contracts from other societies.

A household, or a cooperative farming group, could borrow land from others. This usually happened when the alders the household (or group) farmed had not matured, when the slash-and-burning of new basic swidden failed, when the available community-owned land was of low quality, or when the household (or group)'s other swiddens were still resting. The land borrowed was almost always basic swidden (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 70). Land borrowing agreements were usually for one year. Some land borrowing was cost-free, while some land required payment, usually a piece of Derung blanket, an iron cutting knife, some crops, one handful of Huanglian (a kind of medical plant), or a bucket of alcohol (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 9). Just as in land trading, the price of borrowing land was low compared to its value. The borrower could also compensate the land owner by giving the land owner his land to farm the next year. By the 1950s, there had been 16 cases of land borrowing in Xianjiudang, an administrative village with 62 households and 340 individuals in 1960 (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* pp. 64, 71).

Traditionally, Derung people did not hire wage labor to help in farming. If a family had enough wealth but not enough laborers, they could hold helping sessions. The helping session caller's relatives and close friends were obliged to help (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 9). In these helping sessions, the household that needed help would call other villagers to work on their land and offer food and alcohol to the helpers as they were working. Before wealth differences appeared, each household gave similar hours of help as they received

through these helping sessions. After surplus accumulation appeared, however, the helping sessions became a mechanism of labor acquisition predominantly used by wealthy households. The helpers provided much value through their work, but their "wage" was only 2 meals and some alcohol (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 9).

Between-region variations among the Chinese Derung

Aside from the cooperative farming division rules, Derung traditional farming in different regions differed in other ways. Generally, the level of complexity in farming technology among the Chinese Derung decreased from upstream to downstream villages, and . There were also reports that the Derung in Myanmar having even less advanced complex farming tools and technologies than downstream Chinese Derung (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 2). The reason for this pattern was probably that upstream Chinese Derung people interacted more frequently with more technologically advanced groups, like the Lisu and the Tibetan who had more complex farming technology, more frequently than the downstream Chinese Derung or the Myanmar Derung did.

The decrease in sophistication from upstream to downstream can be seen in many aspects of farming. First, the farming procedures of upstream Derung were more advanced. Alder swidden horticulture and garden land fixed agriculture were first invented and more commonly practiced in Yixiang (including Dizhengdang and Longyuan) (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 50). Second, upstream Derung had better farming tools: Yixiang, Erxiang, and Sanxiang had more iron tools and fewer wood tools serving equivalent functions than Sixiang. Third, farming in upstream was more efficient than in

downstream: the per laborer yield in Dizhengdang, Longyuan, and Xianjiudang was higher than that in Kongdang, Maku, and Bapo.

To me, it is interesting to review the different cooperative farming division rules in upstream and midstream vs. downstream Chinese Derung after learning about the technological and ecological differences. My expectation would have been that the upstream and midstream Derung, who had looser family community structures, more wealth differentiation, and more dependence on farming that divided co-farming harvests by labor, but reality was the opposite. This counter-intuitive pattern could have resulted from the Protestant influence on Bapo and Maku villagers since the 1930s, other cultural factors, or random events and the personal decisions of certain Derung villagers. Unfortunately, ethnographic and historical information is not sufficient to identify the origins of the current division norms.

The Introduction of paddy farming

Chinese Derung people in all regions started farming rice in paddy fields in 1952, under the PRC government's direction. Xuewadang village in Kongdang was selected as the pilot site.

The government officials taught the local people paddy farming procedures and technologies and ran the paddy farming program as an agricultural production co-operative, promoting task divisions and harvest divisions based on detailed labor participation. The rice grew very well in Xuewadang: every Mu of paddy field yielded more than 300 Jin of rice (S. Yang 1999). Paddy farming was thus further promoted to the whole Derungjiang Xiang and was taken on by the people themselves. In Kongdang, people farmed rice as individual households and in cooperative farming groups, but they borrowed the traditions from swidden cooperative farming and divided equally by

household regardless of labor contribution. In the whole Derungjiang Xiang, 850 Mu of paddy was developed between 1952 and 1959 (S. Yang 1999). The success, however, was not replicated everywhere. Probably because of the high altitude, villagers in Dizhengdang reported that the paddy farming program took up much time but yielded little rice and as a result, some people almost starved to death (Guo 2010, p. 104). Consequently, paddy farming quickly disappeared among upstream Chinese Derung. In 2008, only Kongdang, Bapo, and Maku still farmed paddy rice (p. 105).

As a part of the socialist reformation, the paddy farming program introduced both "advanced productivity" (XianJin ShengChanLi) and "advanced productive relations" (XianJin ShengChanGuanXi). Culturally, it was the first time the roles of Derung family community heads and folk religion shamans in directing people's production were challenged. It was also the first time the Derung experienced agricultural production cooperatives (to be introduced in the next subsection), whose rules contradicted their traditions. Derung people were taught to use feces (probably human feces instead of manure but unspecified in the document) as natural fertilizers. This conflicted with Derung traditional beliefs that considered feces to be dirty and unacceptable in farming land (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 100). Derung also adopted plows, different forms of Han hoes and oxen. These technologies and paddy farming itself were abandoned in Dizhengdang, Longyuan, and Xianjiudang when the Chinese Derung took control of their own farming in the 1980s (p. 106).

Agricultural production cooperatives organized by the PRC government

The paddy farming program could be seen as a PRC government agricultural production cooperative, but it was only with a new crop and did not fundamentally

transfer the traditional Derung productive relations. Government-organized agricultural production cooperatives were at the center of the PRC government's socialist reformation and played a critical role in Chinese Derung life between 1957 and 1983 (Guo 2010, pp. 108, 182). In 1957, six agricultural production cooperatives were established in Derungjiang Xiang (He and Li 1995, p. 19). The agricultural production cooperatives confiscated newly developed rice farming land and all group-owned basic or alder swiddens (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 101). They also encouraged individual households to let the cooperatives use alder swiddens owned and farmed by individual households, although such encouragement was not always successful. The participation rate quickly grew. By May 1958, 85% of the agricultural households in Nujiang State participated in agricultural production cooperatives (*Records for Nujiang Lisu Nationality Autonomous State [Nujiang Lisuzu Zizhizhou Zhi],* p. 413). However, interest cooled between 1961 and 1962, because the agricultural production cooperatives proved to be much less efficient than the government thought they would be and provided insufficient food and nutrition for the people (*Records of Gongshan Derung Nationality and Nu Nationality Anonymous County [Gongshan Dulongzu Nuzu Zizhixian Zhi],* p. 13), Nujiang State government started allowing households to withdraw freely in 1961. The participation rate declined from 100% before 1961 to 43% after 1962. Then between 1981 and 1983, land usage rights were gradually returned to individual households, and government-led agricultural production cooperatives ended (Cai 1998, pp. 197-198; *Records of Gongshan Derung Nationality and Nu Nationality Anonymous County [Gongshan Dulongzu Nuzu Zizhixian Zhi],* p. 182).

Bingdang, a village within the administrative village of Kongdang (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 101) was

selected as the pilot site for agricultural production cooperatives in 1955. This pilot program left behind many vivid records that showed how Derung traditions interacted with PRC government policies yielding a compromise. The government-led agricultural production cooperatives aimed to increase productivity by assigning different tasks to individuals with different levels of strength or skills and rewarding resource contribution, labor effort, and labor quality. Specifically, the participation of a plow-pulling ox was worth twice as much as a human laborer's per unit of time. Human laborers were at first classified into 6 types: for each day of work, proactive ones earned 6 points; an average laborer earned 5 points; less devoted ones earned 4 points; half laborers (elders and teenagers) earned 3 points; children earned 2 points or 1.5 points depending on age. The agricultural production cooperatives would then divide the gains based on how many points each participating household's laborers had earned in the farming cycle.

Because these rules contradicted the Derung cooperative farming traditions, the government-led agricultural production cooperatives faced quite a few issues. Traditionally, all households in a cooperative farming partnership would go to the farming plot together, rest together, and go back home together. If they had multiple plots of land to work on, they would work together on one, finish it, and move to the next together. People did not like it when the agricultural production group organizers asked them to take on specific tasks in different land plots. Eventually, the officials had to allow people from the same household to work on different tasks in the same land plot (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 100). Traditionally, Derung people did not acknowledge that the quality and efficiency of laborers could differ. They felt that each person had two hands, and that the elders raised the young people in the past, and children would support

their guardians in the future, so everyone who participated should be equal (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 100). Probably because of this ideology, when the cooperative first started, the villagers in charge of documenting labor participation registered 6 points for all participants. In response to this, the officials shifted to giving 6 points to all adults and 3 points to all children. People were still unsatisfied. Eventually, it was accepted that everyone who worked before breakfast and then again with everyone else after breakfast should earn 6 points, and others who started working only after breakfast should earn 5 points. Traditionally, people in Kongdang divided the gains equally by household regardless of labor participation. This was at odds with dividing in proportion to detailed labor participation, which was at the heart of these communist agricultural production cooperatives. Bingdang people tried multiple ways to fit the division rule of the agricultural production cooperative to their equity ideology. They frequently asked the government officials to give more to the households that had fewer laborers and gained less in the division. They also requested that the last bit should be divided equally among the households and were all extremely pleased when the officials agreed (*Derung Society and History Survey: Vol. 2 [Dulongzu Shehui Lishi Diaocha (Er)],* p. 103). They tried to modify the labor participation counting rules to disadvantage households with more laborers. For example, Kongdang-Zeng had 5 laborers and 6 oxen, so his household earned much more crops than others. This greatly upset the villagers. Some proposed discounting oxen's value in the division, while others proposed oxen should be excluded from production (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 31).

There were no detailed records of how successful the agricultural production cooperatives were in Derungjiang Xiang. Maybe Derung agricultural cooperatives

faced the usual problem that people lacked incentives and no participant was qualified to be the cooperative director, accountant, and so on (Guo 2010, p. 111). Maybe dividing tasks based on skills and dividing gains based on labor contribution promoted work efforts and increased efficiency. However, the fact that Chinese Derung people faced famine and malnutrition in 1959 suggests that the agricultural production cooperatives might have been overall less efficient, or at least less adaptive, than the traditional Derung subsistence style that included hunting and gathering in addition to farming.

After the disappearance of agricultural production cooperatives, Chinese Derung people quickly abandoned the farming technologies and productive relations imposed on them by the cooperatives. They gave up plows, Han-type hoes, and the usage of oxen (Team and Government 1999). Cooperation based on location proximity, which was established in the cooperatives, was also replaced by traditional kinship-based cooperation (D. He 1995, p. 18).

Converting sloping farming land to forests

In Nov. 2002, the PRC government signed a "sloping land conversion" contract with the Chinese Derung (Guo 2010, p. 286). This contract specified that any farming land on mountain areas with a slope of 25° or higher had to be converted back to the forest and that as compensation for giving up their farming land, Derung would receive cash and rice in return. Nationwide, this policy aimed to control erosion and subsequent flooding problems. In Derungjiang Xiang, however, the application of this policy was more about following the national trend than solving local ecological problems: in the Derung Valley, the area of forests taken up for farming was less than 1% of the total surface area, and there was no erosion or flooding (Gros 2014). The contract

between the PRC government and the Chinese Derung was supposed to last for 8 years but was extended in 2010 and eventually ended in 2016. This policy brought many changes to the Derung people's subsistence and general lifestyle.

From 2002 to 2005, 7000 Mu (1.78 Mu or roughly 1187 square meters per capita) of swidden was converted (Guo 2010, p. 286) in Derungjiang Xiang. It was 97.2% of the total area of farming land the Chinese Derung people had at the time. In other parts of China, people received rice according to the area of land they had to give up. In Derungjiang Xiang, probably because almost all land had to be converted and the government wanted to make sure people all received enough rice to bring them up the poverty line, each individual received 374 Jin (187 kg) of rice per year for the length of the contract (p. 287; Gros 2014). It was a significant amount, compared to the 214 Jin (107 kg) of grains (mainly maize) that Derung could harvest from their own farming (Data from Dizhengdang village) (Gros 2014). Currently, although the sloping land conversion contract ended and the Chinese Derung people no longer receive rice, they receive cash compensations that are distributed in proportion to the area of land converted.

The sloping land conversion policy affected the Chinese Derung societies and culture in many ways, some intended, some unforeseen (Guo 2010, pp. 291-297; Gros 2014). First, it pushed swidden horticulture out of the Chinese Derung subsistence. Between the "sloping land conversion" policy and the law that tree cutting requires special permission, the basis for swidden horticulture—using tree ashes as fertilizer, no longer existed. Second, traditional crops, including several forms of millet and several forms of buckwheat, have almost disappeared. These crops were always farmed on swiddens. Since swiddens no longer exist, and people now have easy access to rice, these traditional crops have no role in the contemporary subsistence of the Chinese

Derung. By 2005, 5 out of the 49 crops Derung traditionally farmed had disappeared, and 17 were maintained by only a few households, either to preserve their tradition or because they are older and carry on out of habit. Only 8 were still regularly planted (Shen et al. 2010). Third, because Chinese Derung people now receive rewards for "not working", they find themselves with more free time and grains. This may have led to more manufacture of alcohol and more drinking.

In 2008, Chinese Derung people were granted the right to use forest land that used to be their swiddens. Although still not allowed to cut down trees, they can farm under the trees. In 2010, the Derung nationality poverty elevation program started distributing cash crop seeds and saplings, especially those that could grow well under shading. Among these, the farming of Caoguo (Tsaoko), an herb plant foreign to the Derung Valley, has been extremely successful and become the main cash income source for Derung villagers in Xianjiudang, Kongdang, Bapo, and Maku. A profitable cash crop is yet to be found for Dizhengdang and Longyuan.

Market Integration and Other Recent Changes

The social, political, and ecological conditions the Chinese Derung people face have been changing since 1900, but the changes since 2000 are especially dramatic. In this section, I introduce these changes, and how they may impact the Derung cooperative farming division norms. The changes in transportation, commodity economy and housing are discussed in detail. Other changes are summarized in Table 3.

Transportation

The transportation available to the Chinese Derung in Derungjiang Xiang has undergone three major changes. Before the PRC government-built roads there, the

Chinese Derung had to climb over mountains wherever they went. If they wanted to transport items, they had to carry the items on their backs, because the routes in the mountains were too narrow and too steep for horses. During this phase, there were three main routes that people took, one connecting Derungjiang Xiang and Gongshan to Weixi and Lijiang, one connecting upstream Derungjiang Xiang to Tibet, and a third connecting Maku in Derungjiang Xiang to Putao and thus to the road network in Myanmar. No matter which route people took, the travel was lengthy and dangerous. For example, to go from Longyuan to Dizhengdang, the walk was more than 10 hours, although the direct distance between them was less than 10 km and the walk along car roads now is only 2 hours. In 1964, the man and horse walkway connected Bapo, the center of Derungjiang Xiang at the time, to Gongshan County. This walkway extended to Dizhengdang in 1982 (Guo 2010, p. 212). Since then, items Derung people needed to use or wanted to sell could travel on horseback instead of people's backs. In Oct. 1999, the car road section between Kongdang and Gongshan County was finished (*Records for Nujiang Lisu Nationality Autonomous State [Nujiang Lisuzu Zizhizhou Zhi],* p. 44). The car road between Longyuan and Dizhengdang was completed in 2006 ((p. 212)), marking the official inclusion of all Derungjiang Xiang administrative villages in the Chinese road network. Even after the completion of the road, however, Derung people had to walk if they wanted to go to Gongshan County during wintertime (November to April) because part of the road rose to high altitudes and would be sealed by up to 4 meters of snow. This changed in Dec. 2014, when a tunnel replaced that section of the car road. Nowadays, the road near the tunnel is still occasionally blocked by snow in winter, but because the section is relatively short, the road maintenance team can quickly clean it and restore road usage. Even when the snow is too heavy for road workers to clean promptly, Derung

people can easily have a car drop them off at the point where road access is lost, walk past the snow-sealed section, and have another car pick them up from the other end to continue the transportation. On top of that, the tunnel shortened the travel time from the Derungjiang Xiang administrative villages to Gongshan County by at least 4 hours. The easy year-round access to the market lead to more trading between the Derung in Dulongjiang Xiang and the larger market, reduced their reliance on their own farming products, and prompted more young people to pursue education and wage labor opportunities. Therefore, the ecological significance of co-farming and the difference in various co-farming divisions' ecological payoffs decreased. In addition, the younger generation may acquire a non-Derung interpretation of "fairness".

Commodity economy

Before the PRC government entered in 1950, the Derung people had an underdeveloped commodity economy. They did not have professional businessmen, did not have widely circulating currency, and most traded items with other ethnic groups for necessities that they could not produce. There were, however, already established custom rates of barter between different items. For example, a 30-centimeter-long knife was worth 5 liters of corn kernels, one piece of muntjac skin, one piece of rock sheep skin, or one piece of hemp blanket. In this trading system, iron knives, iron pans, pigs, and cows served the function of currencies (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 23).

The PRC government built a trading center in Derungjiang Xiang on Dec. 25, 1953. From then to the early 1960s, government-run trading stores were built in all administrative villages. Because people did not have money, the very first transaction was still by barter (*Derung nationality [Dulongzu],* p. 23). Later, the trading stores

encouraged Derung people to collect medicinal plants, mushrooms, etc., and sell them to the stores. To protect the Derung people's welfare, the government set minimum prices for purchasing items from Derung villagers, and maximum prices for selling items to them for the stores. This was the first time Derung experienced a commodity economy in their own villages.

Starting in the 1980s, individually run stores appeared in Chinese Derung villages. Although the Derung people had already experienced trading with government-run stores, it was still unnatural for them when the commodity economy among themselves first appeared. The Derung traditional casual exchanging custom was a major barrier. Traditionally, trading among Derung did not have a fixed rate. The exchange was more a form of gifting and helping than trading (*Derung Society and History Survey: Vol. 1 [Dulongzu Shehui Lishi Diaocha (Yi)],* p. 14). Another barrier was the equity ideology. As a Bapo woman store owner said, "In us Derung people, there are still the thousand-year-long original equity thoughts preserved to different degrees. Because people are used to poor life, it is hard to accept that some people can work hard and get richer than others" (*Derung nationality [Dulongzu],* p. 226).

Nowadays, Derung villagers are much more comfortable with exchanges of commodities among themselves. In my field village Dizhengdang, there are more than 10 villager-run stores. Although people could take items and pay later, they have to pay eventually. Even Derung people's own products, like pork, are now sold to fellow villagers and even close kin. In addition, trading became one of the main income sources for some villagers and bargaining became an acceptable behavior. A Derung individual who purchases medical plants from other villagers and brings them into Gongshan County to sell told me, he could only earn 10 CNY for each Jin of plants transported because the villagers were super attentive to prices and would

choose to bring the plants to Gongshan County by themselves if he offers a lower price. Competition has also appeared and occasionally disturbs harmony between villagers. For example, the proprietor of a store gave his sister and her husband (an outsider) his own land to build their store, but later beat the sister and broke her arm because she priced some items cheaper than he did and took business from him. The development of commodity economy may make bargaining between fellow Derung villagers more acceptable in the context of cooperative farming.

Housing

According to Fu and Dong 1763, in the 18th century, most Derung people used grass and wood to build houses, but there were also some who lived in caves. By the 1950s, Derung houses retained the same general form, but no one lived in caves anymore. Traditional Derung houses were mobile. People would move their houses to the plot of land being farmed during that swidden horticulture cycle, to reduce travel time to the land and guard their crops from monkeys and black bears.

In 2014, the PRC government built modern houses Fig. 12 for the Chinese Derung people and requested them to occupy the properties. These houses were built on flat areas that were usually people's farming land. This made the Chinese Derung people's already limited farming land even scarcer. Because usually one or two villages were selected as the resettling locations for the whole administrative villages, the housing program impacted different groups in the same village to different degrees. Take Dizhengdang as an example. The administrative village is composed of six villages, now called groups: Xianghong, with residence locations Nandai and Ban, Mudang, Puer, Xiongdang, Dizhengdang, and Lengmudang. Although required to move, no Xianghong residents did so, because they did not want to live so far away from their

Figure 12. New Houses the PRC Government Built for Chinese Derung People

farming land and did not want to interact with other groups. Mudang individuals acquired a second house with better road and market access. They still mostly lived at their original locations but became better connected to the market and to people from the other groups. Xiongdang and Lengmudang were selected as the locations to resettle the whole administrative village. Because of the housing program, Xiongdang and Lengmudang villagers now have minimal farming land. People from Puer and Dizhengdang moved into their new households and are now between 1h (for most Puer villagers) and 20 minutes distance from their land. This provided a natural experiment for studying how economic, ecological and social environments may influence the Derung cooperative farming division norm.

Table 3. Events and Their Time of Occurrence

Event	Time
Land membrane farming technique introduced to village D	1992
Roadway between Derung town center and county center finished	Oct. 1999
Downstream Chinese Derung missionaries visited village D to spread Protestantism	1999
Electricity entered DZ and LM settlements	May 2001
TVs entered tDZ and LM settlements	May 2001
"Converting sloping farming land to forests" contract began	2002
Roadway between DZ settlement and Derung town center finished	2006
Phone signal entered DZ and LM settlements	Nov. 2007
Right of forest land usage granted to individual villagers	2008
Tunnel replaced roadway section inaccessible in winter between Derung town center and county center	Dec. 2014
PRC government built modern houses for all Derung villagers	2015
China Mobile gifted smart phones to Derung aged 18-50	2015
Protestantism church opened in XD settlement	Sept. 2015
Protestantism church opened in DZ settlement	Oct. 2016
Roadway between XD settlement and XH settlement finished	2016
"Converting sloping farming land to forests" contract ended	2016
Derung town closed to tourists for tourism program development	Oct. 2017
Derung town reopened for tourism	Oct. 2019

Chapter 4

"WHEN WE DO THINGS, WE DO WHAT WE HAVE ALWAYS BEEN DOING": INDIVIDUAL NORM DECISION-MAKING IN A SMALL-SCALE SOCIETY FACING MARKET INTEGRATION

Theoretical Background

To understand whether and how a norm changes under ecological, economic and demographic pressures, we must first understand how people decide what to do in the normative context. Two practices, both common in a group, can react completely differently to new conditions if they rely on different individual motives. Consider the following two examples. The first norm was practiced by certain Kalahari hunter-gathers in early twentieth century. It specified that a hunter could only eat certain parts of his own catch and must give the rest to his band members. Its compliance largely relied on the cultural belief that eating tabooed parts of his catch will lead to the hunter's illness. If this had been the only motivation for the norm, when a hunter was given new information about the health outcomes of eating his own catch, his sharing behavior should readily change. The second norm, in comparison, is supported by positive-frequency-dependent payoffs and most people follow it because it is what others do. One example is the dress code in a workplace. One may prefer wearing jeans and sneakers, but if her co-workers all wear black suits and high heels, she may worry about receiving social disapproval for dressing casually. In this case, the individual's normative behavior would only change if enough others have changed and her assessed social cost sufficiently reduces.

According to Bicchieri (2016), we need to measure five normative elements to

describe a person's norm traits ——1) the normative behaviors: what she does in the normative context; 2) empirical expectations: what she thinks other people will do in this context, i.e., her perceptions of the descriptive norm; 3) private preferences: what she does when social pressure is absent; 4) normative beliefs: how she thinks a person (of a given class, gender, etc.) should behave; and 5) normative expectations: what she thinks her reference group's belief is about how a person should behave, i.e., her perceptions of her reference group's injunctive norm. The reference group is defined as the people whose opinions matter to the focal.

In this theory, empirical expectations drive normative payoff calculations in contexts that require coordination of actions, for example, traffic laws, and usage of languages; whereas normative expectations drive normative payoff calculations if the payoffs come from other group members' reactions to different behavioral variants. Different researchers have used different terms to distinguish these two types of norms, and sometimes the same term to refer to different concepts. In this chapter, I will call the former type structure-enforced norms, and the latter peer-enforced norms.

A rational individual's decision-making algorithm in a context governed by people-enforced norms is shown in Fig. 13: When evaluating her normative behavioral options, she compares them with her normative belief and assigns higher psychological payoffs to the options closer to it. She then balances the options' psychological payoffs with their economic or ecological payoffs, and the winner becomes her private preference, i.e., what she does when social observation and evaluation is absent. When she is in a social context, she needs to add the behavioral options' social payoffs to her considerations on top of psychological payoffs and economic/ecological payoffs. The social payoffs are estimated based on her information about her reference group members' behaviors and attitudes.

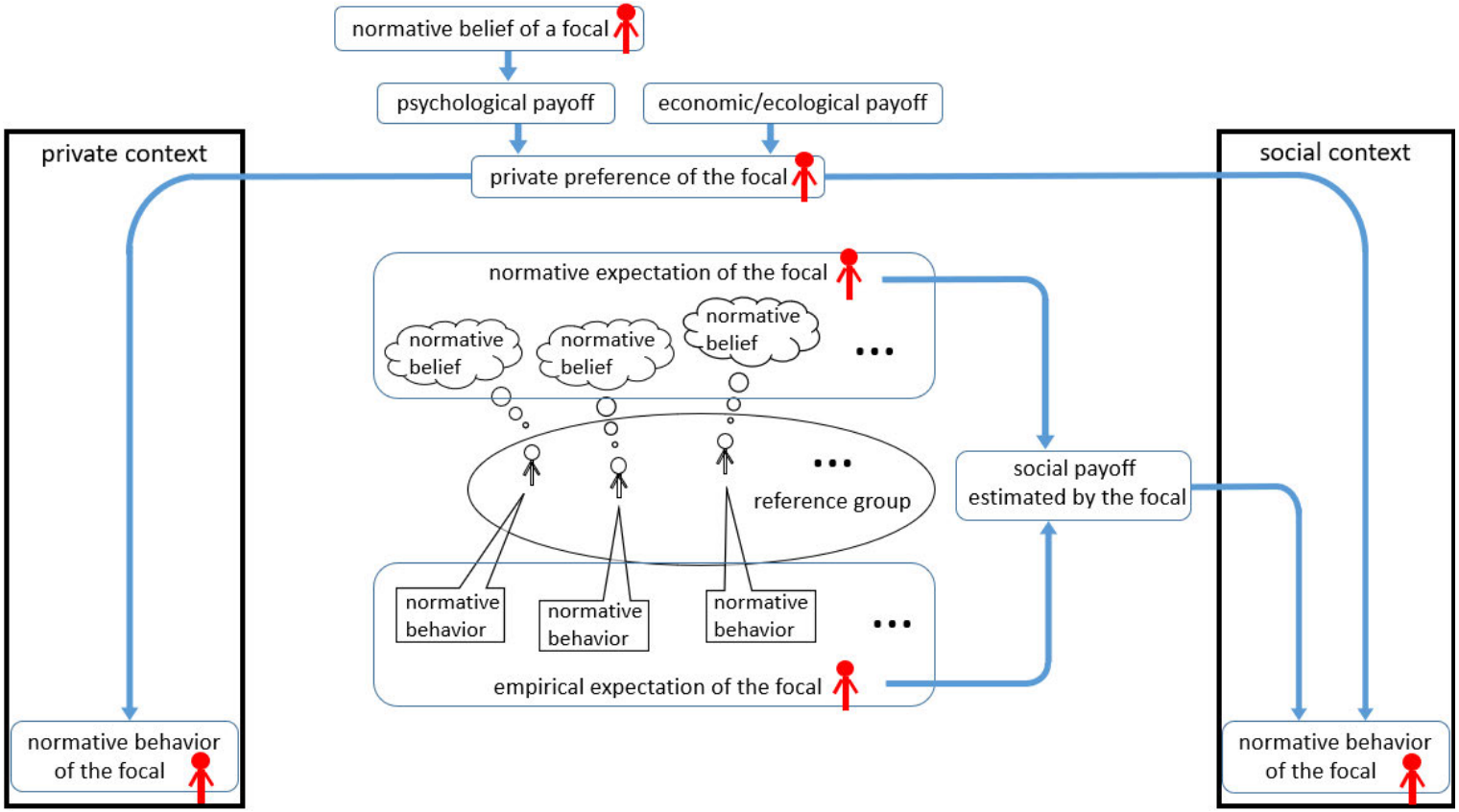


Figure 13. A Rational Person's Norm Decision-Making Algorithm

A rational person decides which normative behavioral variant to adopt by comparing the variants' utilities. In a private context with no observer or evaluator (left branch), a behavioral variant's utility function includes two terms— its psychological payoff and its (perceived) economic/ecological payoff. In a social contexts with observers and evaluators (right branch), a behavioral variant's utility function includes three terms— its psychological payoff, its (perceived) economic/ecological payoff, and its (perceived) social payoff.

Norms often prescribe individually costly behaviors. When a selfish rational person has accurate information about the behavioral options' ecological/economic and social payoffs, the only way to promote their norm compliance is for other group members to impose high social costs on norm violator through gossiping, mocking, withdrawal of help (e.g., Wiessner 2005), or active punishing (e.g., Mathew and Boyd 2011). Norm enforcement can be costly to the enforcers and reduce group efficiency. Thankfully, human evolved psychology allows cultural information to shape one's psychological payoffs and (mis)perceived economic/ecological and social payoffs, such that norm compliance becomes the private preference. A norm can shape one's psychological payoffs through internalization. Once a norm is internalized, the individual wishes to follow the norm even without social monitoring, and experiences negative emotions like guilt and shame if she fails to do so. A norm's psychological payoffs could also come from the culture's interpretation of evolved innate preferences. For example, a norm forbidding marriage between first cousins can rely on a universal incest aversion psychology (Berghe 1983), and the cultural definition of incest as including sex between first cousins. For (mis)perceived economic/ecological payoffs, the food taboo of Kalahari hunter-gathers was an example. Because cultural information is on average individually beneficial, and the linkage between behavioral options and economic/ecological consequences is often opaque, a person can accept the misleading cultural knowledge about a norm's economic/ecological effects as they acquire cultural practices that are actually adaptive. As a result, they follow the norm believing it is in their selfish interests. Occasional norm violations with no consequent adverse effects do not necessarily change the person's belief, because adverse effects may occasionally follow norm violations due to chance, and these loose associations can be enough to reinforce the cultural belief of the norm violator, especially if the believed

ecological/economic cost of the violation is great compared to the benefit. In addition, people do not have the chance to collect social information about how often norm violations lead to adverse effects in others, because successful norm violations are rarely advertised.

By shaping the psychological payoffs, economic/ecological payoffs, and/or social payoffs in individual norm decision-making algorithm, a norm promotes people's behavioral compliance and thus persists. Sometimes, a norm can persist even though it is frequently violated, because the next generation' social learning biases suppress deviants and restore the norm. Norm followers may have more influence on the learners' beliefs and behaviors because they are preferred models. This can happen if the norm compliance behavior is used as a group identity marker so deviants are excluded from the pool of social learning models (e.g., Bucholtz 2012). It may also happen because majority behaviors are used as benchmarks (e.g., Axtell 2006; Liefbroer and Billari 2010), or if norm followers are awarded prestige and social learning is biased toward prestigious models (e.g., Henrich, Chudek, and Boyd 2015). Such social learning decisions may be conscious or unconscious. Norm-maintaining factors that are independent of behavioral compliance is out of the scope of this chapter.

Basics of Co-farming in Dizhengdang Village

Cooperative farming, or co-farming for short, is defined as several households who do not consume the harvests together (for subsistence crops) or deposit their money in one common pool (for cash crops) working together to produce agricultural products. Different from share-cropping, co-farming requires multiple households to conduct labor work. A land owner who provides the land but does not work in it does not count as a participant in the co-farming. Different from helping, a household participating

in co-farming is entitled to a share of the harvests. If a person has contributed labor work to the co-farming, but the amount of reward for their work is casual (often for subsistence crop farming) or pre-set (often for cash crop farming), they count as a helper or a hired laborer, but not a co-farming participant. The Derung phrase for co-farming in upstream Chinese Derung villagers, including Dizhengdang, is "Mengu". The standard for a household or person to count as a co-farming participant as described above is a consensus among the villagers.

Traditionally, Chinese Derung people co-farmed subsistence crops on swiddens. When two or more households voluntarily co-farmed (as opposed to the whole family-community co-farming in which every household was required to participate), upstream Chinese Derung divided equally by household ("household division" or "HD" henceforth) even when different households contributed different numbers of laborers, while downstream Chinese Derung divided equally by frequently-attending laborers ("labor division"). The land provider did not receive more in either region.

To a Dizhengdang villager, here is the ideal arrangement for a subsistence crop co-farming: the participating households each contribute the same number of frequently attending laborers; they schedule days when every laborer is available to work in the co-farming land together; if on a work day additional laborers from any household are available they may also join as helpers; during a work day, all laborers meet at the kitchen of one household to eat breakfast and go to the land together; they take breaks together to eat, drink, or rest, and resume working at the same time; at the end of the day all laborers stop working and go home at the same time. Not being able to achieve the ideal arrangement, however, does not prevent people from co-farming. Households with different numbers of laborers often co-farm. Additional laborers from the co-farming households may also go to work on the land everyday when co-farming

work is done, but they would be considered "helpers" as they are not part of the original arrangement. When some or all laborers from a household cannot attend due to illness, care-taking responsibilities, government work, etc.[6], the partners may work on their own, and the absent party does not need to make up for the missed work.

Most Dizhengdang villagers prefer not to discuss divisions before they see the products. This is true for subsistence crop co-farming, cash crop co-farming, and business partnerships. For subsistence crop co-farming, there is an established division norm, and many partnerships have been continuing for years, so the division discussion after harvesting is often skipped. For cash crop co-farming and business partnerships, most people feel it is useless to discuss how much each partner should contribute and how much each will receive, because the investment cycle is long and there may be unpredictable changes, and these economic activities are new in Dizhengdang and may yield no product or income.

Usually, what counts as a household, the unit to receive a share of the harvests from the co-farming, is based on residence patterns. Occasionally, it is open for discussion. In some cases, the mismatch between household and residence is to adjust for constraints unrelated to co-farming and to accurately reflect the unit of living, for example, when two “households” are economically and diplomatically independent and only living together as the newly-formed household waits for the government to assign or build a new house for them. In other cases, economically and diplomatically coherent household(s) are split or grouped to match the number of laborers from other participant household(s). In one case, a wife and husbanding living together sharing a

[6]The most common government work is forest patrolling. The villagers who work as forest rangers patrol the mountains, usually for one day but occasionally for multiple days, as a group two or three times every month to check for fire hazards, landslide signs, and illegal logging activities. Each ranger receives a monthly wage of 800 CNY.

"Hukou"[7] counted as two 1-person households when co-farming with a household that has only one laborer.

Data Collection Methods

This chapter aims to identify how the subjects in Derung village D decide what to do in a context with an established common practice, i.e., their individual norm decision-making algorithm. This algorithm is interpreted from three research activities: 1) the abstract survey ("*AS*" hereafter) on people's knowledge and attitudes about cooperative farming division rules, 2) the ultimatum game ("*UG*") framed as cooperative farming division, and the post-ultimatum-game attitude survey about behaviors in the ultimatum game, 3) semi-structured interviews on the subjects' real-life cooperative farming partnerships ("*IRL*"). The data presented in this chapter all come from household farming decision makers, although some of them do not participate in cooperative farming or only manage cash crop co-farming.

AS was conducted in 2018. Most of the survey responses were collected by the field assistants independently. Some were collected by a field assistant and the author during training or as quality checks. Three questions from *AS* are used to infer the subjects' normative belief about what the best division rule is and about the contexts this normative belief governs (Table 4).

UG was conducted in 2019 by the author, with the translation from her two field assistants when needed. 74 household farming issue deciders participated in the

[7] A "Hukou" is a PRC government-issued document for a household. It documents basic personal information like names, sexes, birthplaces, birth dates, and national ID numbers of the "Huzhu", i.e., the household head, and the other household members. It identifies each person's residency, which is the basis for government-provided benefits.

Table 4. Survey Questions

parameter	survey question
normative belief	Forget about the current division rules for subsistence crop co-farming. If you are to pick a division rule for the village to follow from now on, what division will you pick?
context for normative belief	Does the rule you like the best depend on the kinship or friendship between the co-farming households?
application to self	Who are you willing to co co-farming with?

game, and 72 out of the 74 answered the post-UG survey. The 74 UG participants were randomly assigned as either the proposer or the responder in one of the two contexts. In the 2:1 context, the participants were told that the proposer household had two individuals living in it and they both participated in the co-farming work every day; while the responder household had only one individual, and this one individual participated in the co-farming every day. In the 2:2 context, both the responder household and the responder household had two individuals and contributed two laborers every day. The land used for the co-farming was framed as borrowed from a third party who did not need to be paid. To match real-life interactional patterns, the proposer was told that their partner would be a randomly chosen individual from the same settlement location. The proposers were asked to divide 50 Jin (25 kg) of rice between their own household and their partner's household. To make the division process ethnographically realistic, the 50 Jin of rice was represented by six pieces of pictures of 5-Jin rice bags, and twenty pieces of pictures of 1-Jin rice bags. The 1-Jin rice bags were placed in four groups of five pieces, so the proposers could use each group as another 5-Jin rice bag, but could also easily break a group apart for

finer divisions. To ensure privacy and anonymity, the proposers divided the rice bag pictures, and put them in the households' corresponding envelopes, in the absence of the author or her field assistants. The responders' behaviors were elicited using the strategy method: they were asked whether they would accept the offer if it had been a certain amount, until the lower and upper limits of their acceptance range were identified.

In the post-*UG* survey, UG participants reported their normative beliefs (their evaluation of how good a behavioral option is) and normative expectations (their expectations about others' evaluations of how good a behavioral option is) about different divisions. Regardless of which role or context a subject played, they evaluated both contexts and the same set of divisions. Which context they evaluated first and whether the division offers they saw were in ascending or descending order in each context was randomized.

The semi-structured interviews about real-life co-farming (*IRL*) was conducted in both 2019 and 2020 by the author, with the translation from her two field assistants when needed. During the interviews, for each of the co-farming they participated in during the year, the subjects reported 1) recalled normative behaviors, including labor participation, land contribution, resource contribution and harvest division, 2) normative beliefs, i.e., what division they thought was best, 3) norm enforcing, i.e., how they would react if their partner(s) propose alternative divisions, 4) normative expectations, i.e., how they expect the partner(s) to react if they propose alternative divisions. *Appendix B* shows a sample interview record.

Yan coded the subjects' norm traits from their interview responses. Cash crop farming only started relatively recently in village D, and subjects had different opinions about whether the division of profits from cash crop co-farming should follow the

Figure 14. What Was Presented to the UG Proposers

After a proposer passed the comprehension test, a piece of paper with a plot of land in the middle and stick figures above and below the land was placed in front of a proposer. The proposer was told the group of stick figures below the land represented their own household, while the other group represented their partner's household. In the 2:1 context, there was 1 stick figure above the land. In the 2:2 context there were 2. In both contexts, there were 2 stick figures below the land. The harvest, represented with rice bag pictures, was then placed on the land. Finally, two envelopes, one with the proposer's name "XXX" and one with "XXX's partner" were placed next to the two groups of stick figures. The researchers left the room after ensuring that the proposer understood their task.

tradition of subsistence crop harvest division in village D, the rule of government-led cash crop agricultural cooperatives, or the cash crop profit divisions from downstream Derung villages, where cash crop farming started earlier than in village D. Therefore, to study how people decide which normative behavioral option to adopt when there is an established tradition, only subsistence crop co-farming is used in coding. Among the subsistence co-farming partnerships, I excluded 3 instances in which the harvest was mostly left at the land due to high transportation costs, because for the households facing such costs, the ecological payoff of receiving more harvests in the division was negative, so the decision of giving the partner(s) more did not reflect their social payoff considerations. Co-farming with few harvests was only considered if the subject did not participate in any co-farming with abundant harvests, because when harvests were few, the people often judged them as unworthy of careful division and free from the division norm's control. Co-farming involving 3 or more households are only if there are no 2-household co-farming with abundant harvests, because a division that needed to be approved by one partner is more reflective of the subject's own norm decision-making than a division that needed to be approved by 6 partners.

If the subjects' multiple 2-household subsistence crop co-farming with abundant harvests followed different division rules or elicited different preferred division reports, one instance from each division or division preference was included. However, no such instance exists in the interview responses[8]. Among a subject's multiple co-farming, which all followed the same division, the most informative one is selected. Specifically, the 2020 data is prioritized because the 2019 field season ended before the harvest

[8]There was one instance where the 2 partner households co-farmed the same types of crops on two plots of land, and divided by household in one and by need in another. Because the divisions of the two plots' harvests were interdependent, they were grouped together as one co-farming partnership. The aggregated co-farming's labor contribution and division was the sum of the two co-farming partnerships.

of most subsistence crops' farming cycles, so the 2019 *IRL* data usually only contain anticipated divisions, but not recalled actual divisions and the discussion process. Among the 2020 co-farming, the one(s) where the partner households explicitly discussed division options are considered, because such discussions revealed the subject's normative preference and justifications. Similarly, co-farming instances with differential recalled labor contribution are considered, because this condition offers the opportunity for the subject to compare household division and labor-based division. Next, the co-farming with more harvests is selected since it is more ecologically consequential.

Following the above coding partnership selection criteria, I compiled a co-farming partnership data set with 50 co-farming partnerships from 62 subjects. Each subject is only associated with one coding co-farming partnership, but a co-farming partnership may have reports from more than one subjects. Specifically, 38 coding partnerships only have the reports from one participant household's decider, 10 partnerships are between two households and have reports from both, 1 partnership has three participant households but is only selected as the coding partnership for two of the households' deciders, 1 partnership is among three households who lived separately from each other and has reports from all three farming deciders, but it was treated as a 2-household co-farming in division[9]. Because more co-farming with HD are omitted than co-farming with alternative divisions, and co-farming with division discussions or differences in contribution are preferably selected, deviations from household division are over-represented in the data set compared to in all real-life co-farming partnerships.

[9]The households treated as one were a mother with her unmarried son and her other married son with his wife. The mother directly reported the co-farming as a 2-household co-farming. The daughter in-law, when asked why their two households only counted as one, answered that it had always been the case. Speculatively, the reason may be that even with the two households counting as one, they had fewer laborers than the other participant household.

Appendix B shows an example interview with subject responses. For each specific co-farming partnership a subject participated in, they reported 1) the basics of the co-farming partnership, including the participants, owner of the land, area of the land, types of crops farmed, kinship between each pair of partners if the author did not already know, and when the partnership started; 2) motivations for co-farming with the partner(s); 3) contributions from the participating households, including recalled labor contribution from each household's members and their helpers, perceived labor contribution comparison between/among the participant households, and recalled resource (seeds, fertilizer, land membranes, etc.) contribution; 4) the normative behaviors of the subject and their partner(s), specifically, how each type of crop was or will be divided, and the division discussion process; 5) the subject's normative belief, revealed by pairwise preference comparisons of different divisions, and the subject's reactions to the vignettes of partner(s)' hypothetical alternative division proposals; and 6) the subject's normative expectations, i.e., how they expect their partners and other villagers to react to their alternative division proposals. Whether and how an interview question was asked depended on the subject's responses to the previous questions. For example, if the recalled discussion process has already revealed the subject's normative attitudes, pairwise division comparison questions and vignette division proposal questions were skipped. Previous pilot work showed that the more vignette questions deviated from reality, the harder Derung subjects found it to answer. Therefore, the alternative divisions the subjects were asked to compare were in most cases limited to what the coding co-farming partnership's arrangements could support. For instance, if the subject contributed more labor, the partner provided the land, they contributed the same amount of seeds and fertilizer and divided equally by household, the subject would be asked to compare HD, the actual division, with

"giving themselves more to reward labor contribution" and "giving their partner more to reward land contribution". The comparison between HD and "rewarding resource (seeds, fertilizer, land membranes, etc.) contribution" would be skipped because the two rules would make the same division since there was no difference in resource contribution. A subject was only asked to compare the actual division with "giving the needier household(s) more" when the co-farming households had different numbers of consumers, or when they reported helping the partner(s) or needing help as a motivation for the co-farming.

Results

In this section, I present an analysis of 92 Derung subjects' norm decision-making algorithm in subsistence crop co-farming division. These 92 subjects were deciders of farming in their households, and have participated in *UG*, *IRL*, or both. Therefore, I have information about both their normative behaviors and their normative attitudes, and can thus analyze how their normative behavior is determined through the algorithm shown in Fig. 13.

HD is the most common division in real life and in the ultimatum game

Out of the 50 coding co-farming partnerships, 13 partnerships' divisions were planned but not completed when the subject was interviewed, 1 had so few harvests that all were saved as seeds for next year's co-farming, while 2 was coded as following division in proportion to need because the harvests were stored together for any partner household to withdraw when they needed it. This leaves us with 34 partnerships with recalled divisions. Among these, 22 partnerships had one participant's recalled division, 11 had two and 1 had 3. Out of the 12 partnerships with multiple division reports, 7

had no disagreement between/among the subjects, 3 had one subject report HD and another report a deviant division, 1 had two reports of deviant divisions that agree on which household received more but disagreed on how much exactly, while 1 had two reports that disagreed on which household received more. This last partnership was dropped. Other disagreements were resolved by taking the average of the reports as the partnership's division. Fig. 15 shows the distribution of the divisions in the 33 partnerships, with division quantified as the share difference between the household receiving the most and the household receiving the least in the division. Therefore, 0 indicates HD, while 100% indicates all the harvests went to one participant household. In these 33 partnerships, HD is the most common reported division (22 out of 33). Given that co-farming partnerships with deviant divisions are over-represented in this data set due to being preferably selected as the coding partnership, HD should be more common as the recalled division in all real life co-farming partnerships.

People's recalls of real-life co-farming division may have been biased toward HD because it was the norm and was cognitively salient. Its accuracy needs to be checked against behavioral documentations. The divisions in the ultimatum game, on the other hand, were directly measured. In *UG*, HD was again the most common division, even when the proposer household had 2 members and the responder household had 1 (Fig. 16).

Some subjects prefer HD as the general rule, but most subjects prefer division by labor

Despite being the most common division behavior, HD is only the generic normative belief of the minority. 33 of the 92 subjects participated in the abstract survey. When

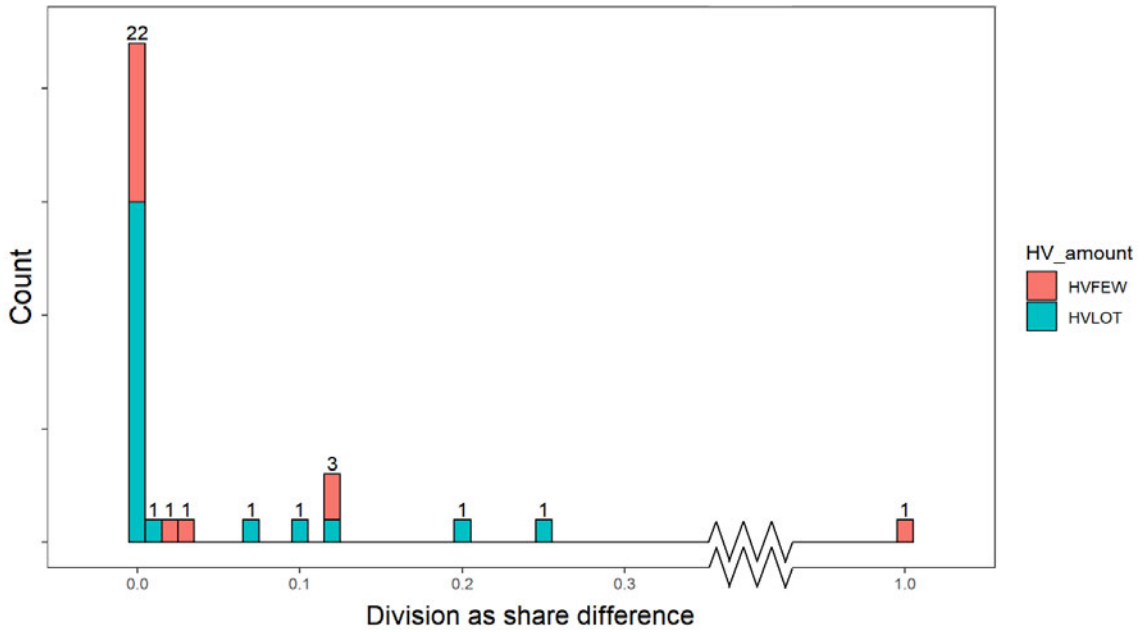
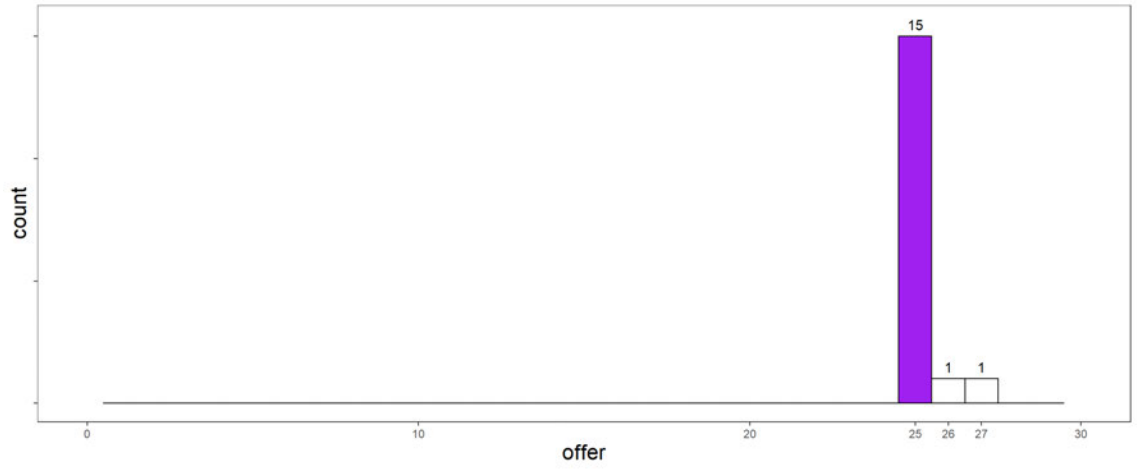


Figure 15. Reported divisions in real-life co-farming

Coral shows the divisions in the 12 co-farming partnerships with harvests fewer than one basket for each participant household. Teal shows the divisions in the 21 partnerships with harvests more than that. Regardless of the amount of harvests, HD is the most common reported division.

asked to choose a harvest division norm for the whole village to follow in subsistence crop co-farming from then on, 19 out of the 33 chose division in proportion to labor contribution ("labor division", labeled "LABOR" henceforth); 13 chose HD; while 1 chose giving the household with more laborers somewhat more but not as much as in proportion to labor contribution. This last division principle is in-between labor division and HD, thus labeled "INBTW". Post-UG survey revealed a similar pattern. 72 subjects out of the 74 who participated in UG took the post-UG survey. 52 reported believing LABOR was the best offer, 13 answered HD, 4 suggested offers within INBTW, while 3 suggested best divisions that overcompensated the household

A



B

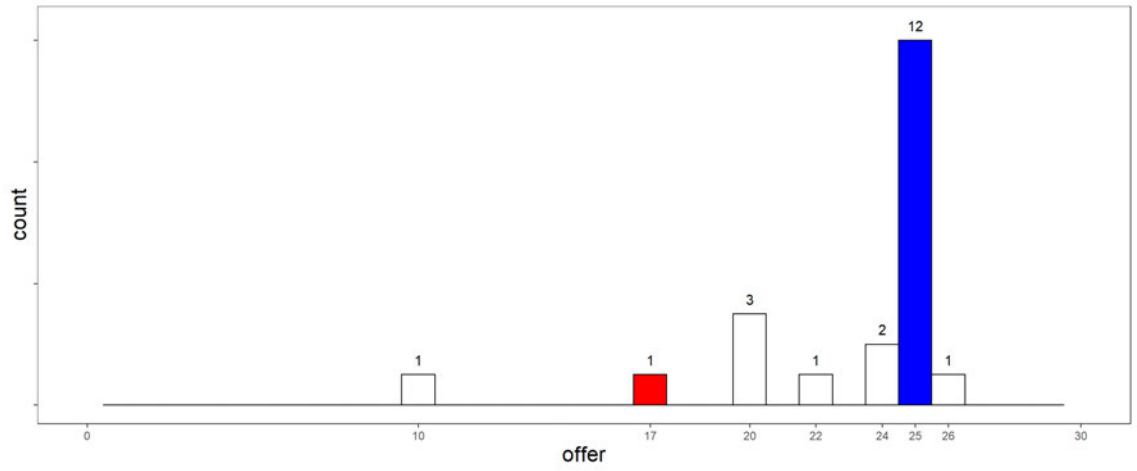


Figure 16. Distribution of Ultimatum Game Proposers' Offers

(A): Offers in the 2:2 context, where both the proposer household and the responder household contributed two laborers. 25 Jin (purple) corresponds to HD and was the most common offer. (B): Offers in the 2:1 context, where the proposer household contributed two laborers but the responder household contributed only one laborer. HD (25 Jin, blue) was still the most common offer, but division in proportion to labor (17 Jin, red), and other offers that rewarded labor to different degrees also existed.

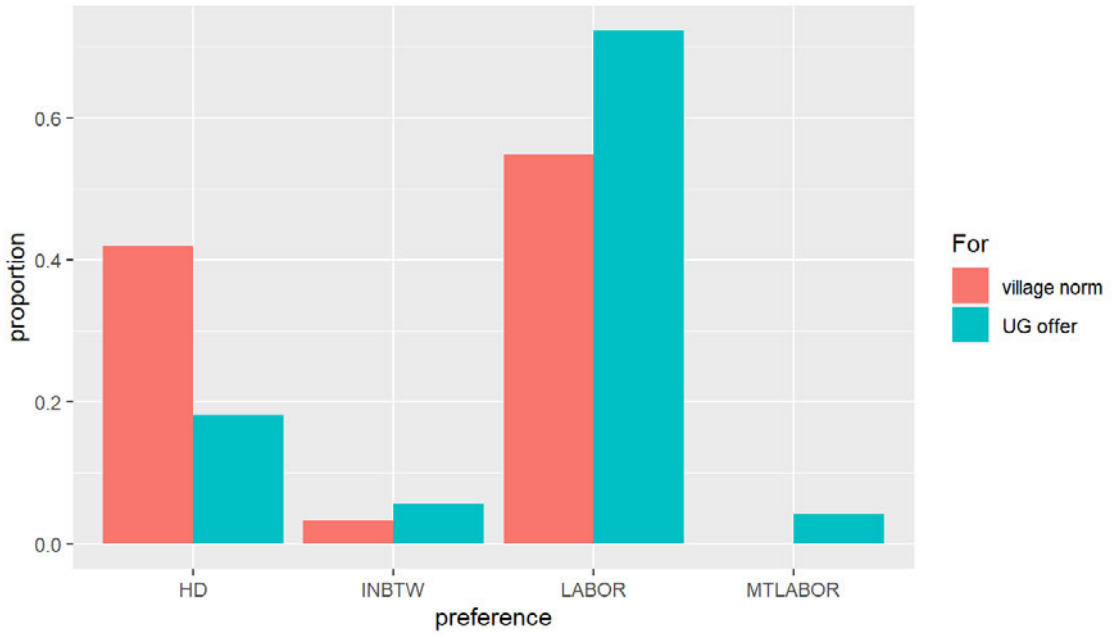


Figure 17. Reported preference for village norm and UG offer

The proportions of HD (household division), INBTW (division inbetween household division and labor division), LABOR (dividing in proportion to labor participation), and MTLABOR (rewarding labor more than dividing in proportion to labor contribution) reported as the best division. Dividing in proportion to labor was believed to be the best division by most people, both as the village norm (coral) and as the 2:1 context offer from the household contributing more labor (teal).

with more laborers[10], labeled "MTABOR" for "more than LABOR". Fig. 17 shows the proportions of reported preferred divisions in the abstract survey and in the ultimatum game's 2:1 context.

Does preferring the currently dominant norm as a general rule reliably predict people's behaviors? A subject is coded as a context-independent or general HD believer if they reported preferring HD as the village norm regardless of kinship or reported preferring HD as the UG 2:1 offer. If a subject only participated in the post-UG survey

[10]Two labor-overcompensating divisions were 35:15, and one was 40:10, potentially because the subjects aimed for labor division (33:17) but adjusted it for ease of implementation.

and reported preferring a non-HD offer in the 2:1 context, their normative belief is coded as undetermined, because the UG setting is highly artificial, and not extending the HD norm to this novel context does not mean a subject does not think HD is right and good in a typical real-life co-farming partnership. With this standard, 24 subjects prefer HD as a general rule independently of the specific co-farming context. 15 out of the 24 HD believers participated in *IRL* in 2019–2020. 12 out of the 15 reported perceiving a labor contribution difference and were asked to compare HD to LABOR or INBTW. 9 out of the 12 suggested they preferred HD. One subject who prefer HD as the general rule but received more than an equal share in their co-farming with 4 partner households suggested that this division was reasonable because his household and his son's household were actually two households, but did not count as two households since one of the four adults needed to stay at home to babysit and they could not contribute two households worth of labor. This subject's deviant division was therefore a flexible application of the HD norm, instead of a direct contradiction to it. The other two HD supporters both deviated to giving the partner household(s) more, although one perceived the partner working more and the other perceived themselves working more, when asked to report their impression on which household worked more. Why they may have done this will be discussed in a later section.

The 9 context-independent HD believers justified preferring HD to LABOR or INBTW in their real-life co-farming with HD being the tradition, HD being fair, and HD being non-calculating, and less specific reasons such as that HD was good while other divisions were not good, co-farming entailed HD, or that they never thought to adopt alternative divisions. Some subjects plainly said there was no reason for their preference. Table 5 shows a sample of the quotes for each justification. Coding these

Table 5. Quotes of Justifications for Preferring HD by Context-Independent HD Believers

Justification	Quote
HD is the tradition	We Derung don't do that. It's all divided equally. There are stories from the past saying you cannot get more in division (and that) equal is good[11]
Co-farming entails HD	It is better for us two households to divide equally. Because we farmed together.
HD is fair	It is not good for one household to have more.
HD is non-calculating	If it is cash crops, it is fine to divide by person. But subsistence crops are all divided equally by household. Because subsistence crops are not worth much money, there is no need calculate so carefully.
HD is good	Because it does not matter that one household has more people eating or more people that worked, it is still the best for us two households to divide equally.
Never thought to deviate	It is still better to divide equally by household. I do not have the thought of getting more for contributing more labor.
No reason	There is no reason. It's just my own thinking. For subsistence crops, it is just best to not track labor contribution and to divide equally by household.

justifications as indicating the preferring HD as the general rule independent of the specific context, 16 out of the 37 subjects who participated in *IRL* but not in *AS* can be seen as preferring HD as the general rule. This proportion (43.2%) is comparable to the proportion of context-independent HD believers (39.4%) revealed in *AS*.

[11]When village D subjects said "equal", it always meant "equal by household". I asked each subject

Close social ties promote shift of preference to HD

People who do not prefer HD as a general rule may still think the norm is better than the alternatives under certain conditions. For the Derung subjects, close social ties promoted their preference to shift from labor division to HD. In the abstract survey, after indicating their preferred subsistence co-farming harvest division norm for the whole village, the subjects were asked whether their preferred rule would change based on kinship or friendship between the co-farming partners. 7 among the 19 that reported preferring labor division and 0 among the 13 that reported preferring HD answered yes. One subject that preferred labor division as the general norm explicitly suggested HD as the division for co-farming among kin. Another subject explicitly suggested dividing in proportion to need, implemented as storing the harvests together and allowing either/any partner household to withdraw as needed.

The impact of social ties on preferred division could also explain the subjects' attitude change from the abstract survey to the post-UG survey. 28 subjects participated in both *AS* and the post-UG survey. Among the 12 who prefer HD as the village norm, only 2 reported believing HD was the best offer in the UG 2:1 context, while 1 shifted to INBTW and 9 shifted to LABOR. The one subject preferring INBTW as the village norm preferred LABOR as UG offer. The 15 subjects who preferred LABOR as the village norm largely (13 out of 15) remained preferring LABOR, but 1 subject shifted to HD and one shifted to rewarding labor even more than dividing in proportion to labor contribution ("MTLABOR"). Therefore, the general trend to shift toward rewarding labor contribution more in UG, where the partners were anonymous so there was no existing social ties, and no potential of developing social ties. The

"equal by what?" when they first mentioned "equal division" in the interview, and adopted the subject's definition without repeating the question for additional references.

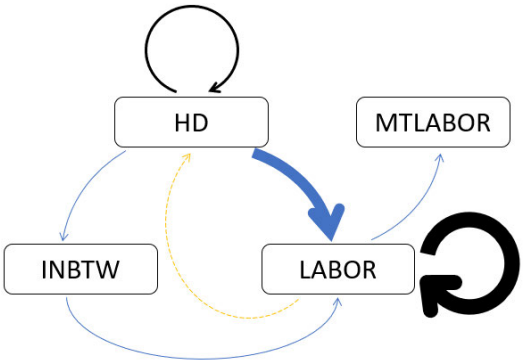


Figure 18. Preference Shift from Village Norm to UG Offer

How the subjects shifted (or did not shift) their preferred division from as the village norm in *AS* to as the 2:1 context UG offer in the post-UG survey. HD: dividing equally by household. LABOR: dividing in proportion to labor contribution. INBTW: rewarding labor contribution but not as much as in proportion to labor contribution. MTLABOR: rewarding labor contribution more than in proportion to labor contribution. The arrows going from one division to another indicate a preference shift. The arrows from a division to the same division indicate the same preference in both. The width of the arrows is proportional to the number of subjects with that preference shift or with that preference persistence. Blue arrows are shifts toward rewarding labor contribution more heavily. The yellow arrow is shift toward rewarding labor contribution less. Black arrows represent no change.

one subject who shifted from LABOR as village norm to HD as UG offer was a young adult who only established their own household and started managing farming independently in 2019.

The 20 subjects who reported preferring a non-HD division as the village norm or preferring different divisions for partnerships with different relationships were coded as not preferring HD as th general rule. Out of the 20 HD non-believers, 3 did not participate in *IRL*, 1 was only in charge of cash crop farming so his wife reported on the household's subsistence co-farming, 1 chose not to co-farm because it was hard to organize when to work in the land together, while 15 participated in one or more co-farming partnerships in 2019 o 2020 and reported them in *IRL*. Given 15 of the 16

HD non-believers with known behaviors still participated in co-farming, not preferring the prevalent division norm as the general rule did not prevent the Derung subjects from voluntarily entering the context governed by the norm. The 15 HD non-believers who reported their co-farming in *IRL* were each associated with a different co-farming partnership. 8 subjects thought their households and their partner(s)' household(s) contributed different amount of labor work. Among the 8 subjects, half retained their preference for labor division and answered that in the specific co-farming, giving the household who contributed more labor more harvests was better than HD; the other half switched their preference and suggested they preferred following HD in the specific co-farming. The reasons given by the 4 belief switchers for preferring HD in their coding real-life co-farming partnerships included 1) having a good relationship with the partner; 2) living in the same village as the partner; 3) expecting the partner(s) to prefer HD; and 4) both households equally benefiting from receiving additional harvests.

Preferred divisions in real-life co-farming and justifications for them

Out of the 62 subjects who participated in *IRL*, 47 compared HD and LABOR, which would divide harvests in proportion to labor contribution, or INBTW, which would give the household doing more labor work somewhat more but not as much as in proportion to labor contribution. The others' preferences on how to divide subsistence crop harvests based on labor contribution cannot be inferred in their coding co-farming partnership[12]. Among the 47 subjects, 29 preferred HD, 12 preferred INBTW,

[12]When a subject's preference on how to divide based on labor could not be inferred, it was usually because another division rule overwrote labor contribution considerations, and the subject would not answer which division they liked better or would implement if they were in charge. For

Table 6. Quotes of Justifications for Preferring HD by Context-Dependent HD Believers

Good relationship with partner	Because we have a good relationship, so even when we divide equally by household, it will not be a loss for me.
Partner is a fellow villager	We live in the same place. It is inappropriate for me to receive more harvests for more labor contribution.
HD is partner's preference	Although my daughter's household contributed more labor, it is still better to divide equally by household. She herself would not want to take more. If we do not divide equally by households, some households would get more and some households would get less, and there may be bad feelings.
Needs equally unsatisfied	It is better to divide equally by household. My daughter's household cannot grow potatoes or corn where they live. So although I do not have enough to eat, neither does my daughter, so it is better to divide equally by household.

1 preferred LABOR, 4's preference depended on whether they or their partners contributed more labor, while 1 answered they did not know which was better. Note that the reported preference may have depended on the labor contribution comparisons between the subject and their partner(s) even when it was not explicitly stated. For example, a subject may have perceived their household as contributing more labor in the coding co-farming partnership, and answered that they believed HD was the better division, but deemed the vignette question "If your partner(s) contribute more labor, which division is better?" as too unrealistic to be answered.

example, four subjects indicated that their co-farming partners were in charge of the division and they had no thought other than listening to the partners.

Table 7. Justifications for Preferring Dividing Equally by Household in Real-Life Co-farming and Their Labels

Justification	Label
HD is the tradition	TRAD
Co-farming entails HD	CFHD
HD is fair	FAIR
HD is non-calculating	NCCL
HD is good	GOOD
Never thought to deviate	NTHD
No reason	NRSN
Good relationship with partner	GDRL
Partner is a fellow villager	FVLG
HD is partner's preference	CFPP
Needs equally unsatisfied	NDUS
The co-farming group followed HD in the past	GRHS
Subject followed HD when co-farming with others in the past	SBHS
HD is more convenient than tracking labor contribution	CVNT
The co-farming partners are families	FMLY
The co-farming is to help one party	HELP

Table 7 offers a comprehensive list of the subjects' justifications for preferring HD in their real-life co-farming. Fig. 19 shows how many subjects provided each justification for their HD preference in the coding co-farming partnership.

When a subject answered they preferred LABOR or INBTW, they usually restated

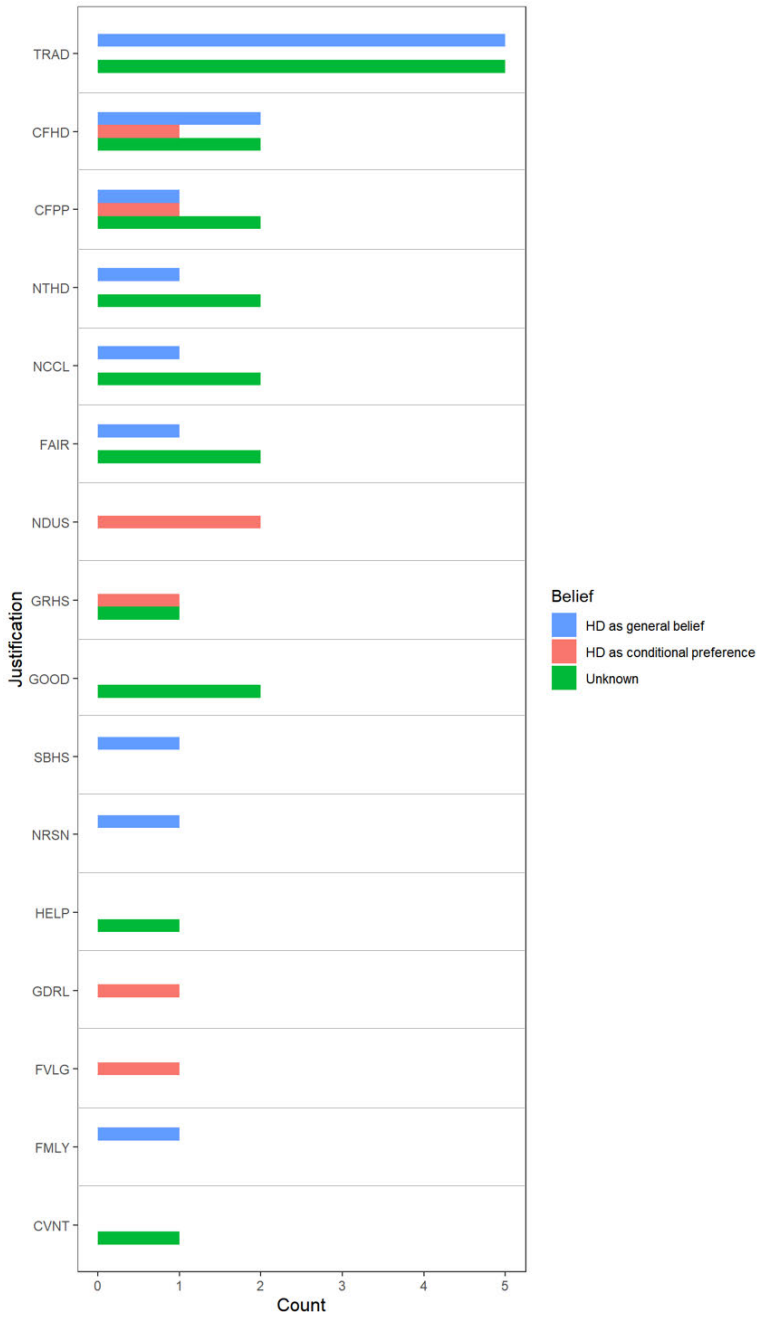


Figure 19. Justifications for Preferring Household Division in Real-Life Co-farming

The distribution of the 29 subjects' justifications for preferring household division in their real-life co-farming partnerships. Among the 29 subjects, 8 (blue) reported preferring HD as the village norm in *AS*, 6 (coral) reported preferring LABOR in *AS*, and 15 (green) did not participate in *AS*. Each subject could provide as many justifications as they wanted.

the preference itself as the justification by saying "because I/they contributed more labor". The only exception was that a subject who chose HD as the village norm justified his household receiving more for contributing more labor with "we are actually two households". The details of this case have been discussed in a previous section.

Most subjects know most others prefer division by labor

One possibility why a norm disliked by most people persists is as a "public lie" due to pluralistic ignorance— Although people themselves don't like the norm and only follow it to avoid sanctions, they incorrectly infer other people's preferences from their behaviors and conclude that most others like the norm, and that they would be punished if they expressed their true preferences. The communist regime in East Europe before 1991 was argued to be maintained by this mechanism (Kuran 1995). This is not why HD was the most common offer in the UG 2:1 context. The 72 subjects in post-UG survey were incentivized to guess what most other people in the village would think the best division was for the two contexts, and most subjects correctly guessed that most others prefer labor division in the UG. Instead of believing the "public lie", subjects projected their own "private truth" onto others when guessing the population preference distribution— Treating "HD", "INBTW", "LABOR" and "MTLABOR" as ordinal categorical variables, the Polychoric correlation between a subject's own reported preference and their guess of most others' preference is 0.56.

Behind the HD norm is the moral preference for cooperativeness

Three lines of evidence suggest that HD itself is not the ultimate principle, but one expression of being a caring and generous partner. First, when Dizhengdang subjects' reported preferences or real-life division proposals deviated from HD, most were toward

giving the partner(s) more. 9 subjects in *IRL* compared HD with LABOR or INBTW for both when they contributed more labor and when their partner(s) contributed more labor. 5 reported preferring the same division rule regardless of which household contributed more labor. 4 reported preferring INBTW when their partner(s) worked more but preferring HD or being indifferent between HD and INBTW when they worked more. Looking across the preferred divisions based on contribution differences in labor, land, or resource, 20 subjects had both preferred divisions that gave their partner(s) more and preferred divisions that gave themselves more; 31 subjects' one or more preferred divisions gave their partners more; 3 subjects' preferred divisions gave themselves more. Because the subjects were only asked to compare divisions that could apply to their co-farming arrangements and some subjects only made one pair of comparison, whether a given subject's preferred divisions gave their partner(s) or themselves more may reflect their rule about whether a contribution should be rewarded instead of their rule about generosity. However, unless Dizhengdang subjects tended to choose subjects who could contribute more in the domain they thought should be considered in harvest divisions, the difference in the number of subjects whose preferred divisions gave their partners more and the number of subjects whose preferred divisions gave themselves more indicate being generous was the moral principle behind the subjects' reported preferences.

Second, most real-life deviant proposals were generous. Among the 33 co-farming partnerships with recalled divisions, 12 experienced discussions where non-HD proposals were raised. The discussion in one happened before the co-farming started, and according to the subject, she and her partner both proposed the partner's household should receive more in division for contributing more labor. The discussion in the other 11 happened after harvesting. All 11 deviant proposals gave the partner(s)

more and the proposer less. In addition to the 11 generous deviant proposals, there was one co-farming partnership where the party in charge of the dividing process directly poured the last bowl of peas into the partner's bag. The same willingness to make generous but not selfish deviations was revealed by the subjects' answers to vignette proposals. 26 subjects were asked to guess how their co-farming partner(s) would react to their deviant division proposals. 14 were only asked about their selfish deviant proposals, 5 only generous ones, and 7 both. 2 out of the 14 and 3 out of the 7 refused to guess how their partner(s) would react to their selfish proposals and said they would not do so. No subject, including the 3, refused to guess how their partner(s) would react to their generous proposals.

Third, most real-life and vignette reactions to deviant proposals from their partner(s) were generous. To the 11 generous deviant proposals from their partners, 4 responders directly accepted them, 4 responders rejected them and their co-farming still followed HD, 3 responders rejected them but the proposers insisted or implemented them in action despite the responders' objections. 23 subjects were asked whether they would accept their partner(s)' generous vignette proposals. 3 said they would directly accept it, 2 said they would accept it if their partners insisted but would first say "That's not needed", while 18 said they would firmly reject it.

How do Dizhengdang villagers balance HD and giving their partner(s) more? Before the partner(s) household composition is revealed and before the contributions are made, HD is more cooperative and less "calculating" than dividing in proportion to labor contribution. Once the co-farming households' contributions and needs are known, however, the differences in these domains offer a basis for people to offer more to their partners. This explains why the two HD supporters gave their partner household(s) more, one justifying it with the partner being more in needs, and the

other justifying it with the partner having contributed more labor, in their coding co-farming instead of following HD (see section "Some subjects prefer HD as the general rule, but most subjects prefer division by labor").

HD is the default. Deviant proposals carry cultural signals/cues

Because friendship and kinship shifts Dizhengdang villagers' preference to HD, HD could signal valuing the co-faming partner(s), feeling close to them, and having a strong bond with them. To a Dizhengdang subject, HD itself did not serve as a signal because it was largely followed and often the default— Out of the 33 co-farming partnerships with reported divisions, 18 followed HD without discussion it and 2 had HD as the only proposal[13]. However, deviant division proposals, especially selfish ones, may be interpreted as the proposer being calculating, complaining about the partner(s)' level of contribution, or not getting along with the co-farming partner(s). Table 8 lists such instances, detailing the co-farming context, the deviant proposal, the interpreter of the deviant proposal, the signal that the interpreter decoded (when the interpreter is the subject) or was expected to decode (when the interpreter was someone else) from the deviant proposal, and the action the interpreter would take or was expected to take. To save space, "household" is abbreviated as "HH", "co-farm(ing)" is abbreviated as "CF", "labor(er)" is abbreviated as "LB","the subject" is abbreviated as "SBJ", "the co-farming partner(s)" is abbreviated as "CFP", and other villagers who were not participants of the co-farming is labeled "TRD" for third party. All deviant proposals interpreted negatively in this data set were vignettes.

[13]Because co-farming partnerships with discussions were prioritized as coding partnerships, following HD by default should be more common in all real-life co-farming.

Table 8. Cultural Signals Associated with Deviant Proposals

Context	Proposal	Interpreter	Interpretation	Action
Two HH both with 2 LBs have been CF for 3 years. In 2020, SBJ's husband passed away.	CFP proposes CFP should get more for more LB contribution.	SBJ	CFP is complaining about SBJ not contributing as much LB.	SBJ will end the CF.
Same CF as above	CFP proposes CFP should get more for having more consumers.	SBJ	CFP needs more crops.	SBJ will continue the CF next year.
SBJ is CF with her husband's brother's HH and her husband's sister's HH. SBJ's HH contributes 3 LBs. Two CFP's HH both contribute 2 LBs.	CFP proposes CFP should get more for more LB contribution.	TRD	It is too calculating and not good. The CF HHs are kin after all.	None
SBJ provided all the seeds and fertilizer for the CF.	SBJ proposes SBJ should get more for resource contribution.	CFP	SBJ has a bad heart. It is just a bit of seeds and fertilizer yet SBJ wants more.	None
CFP provided the land but SBJ contributed more LB.	SBJ proposes CFP should get more for providing the land.	CFP	It is weird. Why did SBJ say this?	None
SBJ' and CFP's HHs both have 2 LBs, and both miss work occasionally. Work is on-going at time of the interview.	SBJ proposes tracking attendances. The HH attending more gets more in division.	TRD	That's funny.	None

"When we do things, we do what we have always been doing" even in a private context

In real-life co-farming partnerships, not raising selfish deviant division proposals and rejecting partners' generous deviant division proposals signal how much one cares about their partner and values the partnership. This social payoff consideration combined with the belief that the household(s) contributing the land, more labor, or more seeds and fertilizer has/have more of a say in the division could explain why HD is often the division in real-life co-farming despite being the less frequently preferred general division rule. However, it does not explain why HD was the most common offer in the UG 2:1 context. There were 8 subjects who reported believing LABOR was the best offer and expecting most others to believe LABOR was the best offer, but offered 25 out of 50 in the 2:1 context. When asked why, the consensus answer was, "What people think is just what people think. When we do things, we do what we have always been doing."

Discussion

Dizhengdang villagers mostly divide equally by household ("household division" or "HD") when they co-farm subsistence crops. For some, they prefer HD as a general rule and will apply it regardless of who they are co-farming with or which household makes more contributions. For others, they prefer HD or generous deviations from HD specifically when they are co-farming with friends or relatives, fitting the predictions from reciprocity theory and kin selection theory. Whether such considerations count as ecological payoffs or social payoffs is a call of judgment. When both psychological payoffs and ecological or social payoffs fail to promote a Dizhengdang villager to follow HD, the willingness to do what others do may still lead to their norm compliance.

Like several previous studies conducted in industrialized large-scale societies (e.g., Bicchieri and Xiao 2009; Cialdini 2007; Schultz et al. 2018), I discovered that Dizhengdang villagers base their actions on descriptive norms rather than injunctive norms. This individual norm decision-making algorithm contradicts the rational choice theory's prediction that people should calculate their social payoffs in a peer-enforced norm from their perceptions of the injunctive norms. Peer-enforced norms are, in fact, often enforced by social learning, a cost-free mechanism. The reason why people care more about what others do than what others say they think one should do may be that actions are costly while words are cheap, so following a norm adds to the credibility of a potential social learning model (Henrich 2009). The heavy reliance on social information does not rule out the possibility that social costs will be imposed on frequent norm violators, but in the Dizhengdang co-farming case, frequent violators and social sanctions toward them are rare if not absent, and social costs, if considered, are done so unconsciously.

Does the heavy reliance on social learning warrant reducing a norm to just another cultural trait? Not necessarily. People may have a norm psychology that fine-tunes their social learning based on the nature of the context and the norm tightness-looseness level of the society. If people give more weight to social information when facing social issues than ecological problems, it would suggest that considerations of potential social monitoring and policing, a defining property of social norms, are driving the decision-making. In human societies, however, there is hardly any problem that is purely ecological. Actions that do not harm unrelated individuals, like incest, are taboos in most cultures. Another test that would suggest people have a norm psychology above and beyond a social learning psychology is if people in norm-tight societies, where more actions are monitored and evaluated by others and deviations are

more harshly punished, give social information more weight than people in norm-loose societies. More studies on individual norm decision-making in a wider range of societies are needed to reveal the human norm psychology.

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Local Collaborators

The abstract survey data were collected by the following four local collaborators after they completed the training– Li Fuqiang, Li Mu, Long Huasheng, Li Zhizhong. The ultimatum game was completed by the author with the translation of the following two local collaborators– Li Yuanmei, Li Zhizhong. The post-ultimatum game survey was completed by the author with the translation of the following two local collaborators– Li Xiaomei, Li Zhizhong. The interviews on real-life co-farming partnerships were conducted by Minhua Yan with the translation of the following two local collaborators– Li Yuanmei, Li Zhizhong. Among these local collaborators, Li Yuanmei and Li Zhizhong made insightful suggestions about the interview questions' design and will serve as co-authors on the publications based on this data set if they agree to.

Data Dissemination to the Participants

I will summarize the results in this chapter in plain language. My local collaborators will visit all the participants, report the results to them, and collect their feedback. The participants can choose to withdraw their responses.

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APPENDIX A

MATHEMATICAL PROOF FOR THE BASE MODEL AND ITS EXTENSIONS

This appendix corresponds to Chapter 2. It contains two parts. Part 1 shows the calculations of the individual payoff in distribution-reliant effects. Part 2 shows the calculations evolutionary dynamics.

Payoff in Distribution-reliant Effects

Here I show the calculations of individual i's aggregated payoff $W_R(x_i)$ from the effects that depend on not only her own norm trait value x_i, but also the population's norm trait distribution. When there is no direct effect on groups, $W_R(x_i)$ is equivalent to $W_S(x_i)$, the expected payoff of individual i with norm trait value x_i in similarity-based normative effects. When there are direct effects on groups, we have $W_R(x_i) = W_S(x_i) \times W_G(x_i)$, where $W_S(x_i)$ is individual i's expected payoff in normative effects and $W_G(x_i)$ is her expected payoff in group direct effects. The first two sections calculate the similarity-based normative payoff as defined in the base model and show that its optimum is the population mean norm value when the normative effects are weak (*A.1*) or when the population norm value distribution is normal (*A.2*). The rest correspond to the base model's extensions, and calculate the aggregated payoff in distribution-reliant effects, denoted as $W_R x_i$, which include similarity-based norm effects and similarity-independent direct effects on the group.

Individuals belong to a large population, and each is characterized by a continuously varying norm. The norm value for individual i is x_i. The distribution of norm values in the population, $\phi(x)$, has mean μ and variance V.

1. Two-person coordination - weak selection

Partners in similarity-based normative interactions are paired randomly. The normative payoff of to an individual with norm value x_i when paired with an individual with norm x_j is the Gaussian function

$$W_R(x_i|x_j) = \exp\left\{-\frac{(x_i - x_j)^2}{2S}\right\} \tag{A.1}$$

where S indicates the strength of selection and is proportional to the inverse of fitness function's variance. With $S = 0$, all pairings have the same payoff 1.

The expected payoff of an individual with norm value x_i given the above norm selection fitness function is thus

$$W_R(x_i) = \int W_R(x_i|x_j)\phi(x_j)\,dx \tag{A.2}$$

where ϕ need not be normal. Now suppose that selection is weak so that $S \gg V$. Then the higher power terms in the Taylor series of Eq. (A.1) can be ignored, and we have:

$$W_R(x_i|x_j) \approx 1 - \frac{(x_i - x_j)^2}{2S}$$

and we can compute the expected fitness of an individual with norm x_i as

$$\begin{aligned} W_R(x_i) &= \int W_R(x_i|x_j)\phi(x_j)\,dx_j \\ &\approx 1 - \frac{x_i^2 - 2x_iE(x) + E(x^2)}{2S} \\ &\approx 1 - \frac{x_i^2 - 2x_i\mu + \mu^2 + V}{2S} \\ &\approx 1 - \frac{(x_i - \mu)^2 + V}{2S} \\ &\approx \exp\left\{-\frac{(x_i - \mu)^2}{2S}\right\} - \frac{V}{2S} \\ &\approx \exp\left\{-\frac{(x_i - \mu)^2}{2S}\right\} \end{aligned} \tag{A.3}$$

2. Two-person coordination - normal distribution of normative traits

We relax the assumption that selection is weak but impose the assumption that the distribution of norm values in the population is normal. First notice that

$$W_R(x_i|x_j)\phi(x_j) = \frac{1}{\sqrt{2\pi V}} \exp\left\{-\frac{(x_i - x_j)^2}{2S} - \frac{(x_j - \mu)^2}{2V}\right\} \tag{A.4}$$

Now expand the exponent, Z, and complete the square

$$
\begin{aligned}
& Z \\
&= -\frac{V\left(x_i^2 - 2x_i x_j + x_j^2\right) + S\left(x_j^2 - 2x_j\mu + \mu^2\right)}{2SV} \\
&= -\frac{(V+S)\,x_j^2 - 2\left(Vx_i + S\mu\right)x_j + Vx_i^2 + S\mu^2}{2SV} \\
&= -\left(\frac{V+S}{2SV}\right)\left[x_j^2 - 2\left(\frac{Vx_i + S\mu}{V+S}\right)x_j + \left(\frac{Vx_i^2 + S\mu^2}{V+S}\right)\right] \\
&= -\left(\frac{V+S}{2SV}\right)\left[x_j^2 - 2\left(\frac{Vx_i + S\mu}{V+S}\right)x_j + \left(\frac{Vx_i + S\mu}{V+S}\right)^2\right] \\
&\qquad\qquad -\left(\frac{V+S}{2SV}\right)\left[\left(\frac{Vx_i^2 + S\mu^2}{V+S}\right) - \left(\frac{Vx_i + S\mu}{V+S}\right)^2\right] \\
&= -\left(\frac{V+S}{2SV}\right)\left[x_j - \left(\frac{Vx_i + S\mu}{V+S}\right)\right]^2 \\
&\qquad\qquad + \frac{V^2x_i^2 + 2SVx_i\mu + S^2\mu^2 - (V+S)\left(Vx_i^2 + S\mu^2\right)}{2VS\,(V+S)} \\
&= -\left(\frac{V+S}{2SV}\right)\left[x_j - \left(\frac{Vx_i + S\mu}{V+S}\right)\right]^2 + \frac{2SVx_i\mu - VS\mu^2 - VSx_i^2}{2VS\,(V+S)} \\
&= -\left(\frac{V+S}{2SV}\right)\left[x_j - \left(\frac{Vx_i + S\mu}{V+S}\right)\right]^2 - \frac{(x_i-\mu)^2}{2\,(V+S)}
\end{aligned}
$$

Thus the expected fitness of an individual with norm value x_i is

$$
\begin{aligned}
& W_R(x_i) \\
&= \int W_R(x_i|x)\phi\left(x_j\right)dx_j \\
&= \frac{1}{\sqrt{2\pi V}}\exp\left\{-\frac{(x_i-\mu)^2}{2\,(V+S)}\right\}\int \exp\left\{-\left(\frac{V+S}{2SV}\right)\left[x_j - \left(\frac{Vx_i + S\mu}{V+S}\right)\right]^2\right\}dx_j \\
&= \frac{1}{\sqrt{2\pi V}}\exp\left\{-\frac{(x_i-\mu)^2}{2\,(V+S)}\right\}\sqrt{\frac{VS}{V+S}}\sqrt{2\pi} \\
&= \sqrt{\frac{S}{V+S}}\exp\left\{-\frac{(x_i-\mu)^2}{2\,(V+S)}\right\} \\
&\propto \exp\left\{-\frac{(x_i-\mu)^2}{2\,(V+S)}\right\} \qquad \text{(A.5)}
\end{aligned}
$$

Notice that when $S \gg V$

$$W_R(x_i) \approx \exp\left\{-\frac{(x_i-\mu)^2}{2S}\right\}$$

Which approximates the weak selection result.

3. Assortative interaction between two individuals

With assortment, partners with more similar norm traits are more likely to interact. Given that a focal individual i has norm trait value x_i, and that the assortment coefficient between partners is r, the distribution of i's partner's norm value x_j follows a normal distribution: $X_j \sim N(rx_i + (1-r)\mu, V)$.

$$\begin{aligned} W_R(x_i) &= \int W_R\left(x_i|x_j\right)\phi(x_j)dx_j \\ &= \frac{1}{\sqrt{2\pi V}}\int \exp\left\{-\frac{(x_i-x_j)^2}{2S} - \frac{\big(x_j-[rx_i+(1-r)\mu]\big)^2}{2V}\right\}dx_j \end{aligned}$$

We expand the exponent Z and complete the squares with respect to x_j:

$$\begin{aligned} Z &= -\frac{(x_i-x_j)^2}{2S} - \frac{(x_j-[rx_i+(1-r)\mu])^2}{2V} \\ &= -\frac{(S+V)x_j^2 - 2\big(Vx_i + S[rx_i+(1-r)\mu]\big)x_j + Vx_i^2 + S[rx_i+(1-r)\mu]^2}{2SV} \\ &= -\frac{(S+V)}{2SV}\Big(x_j - \frac{Vx_i + S[rx_i+(1-r)\mu]}{S+V}\Big)^2 \\ &\qquad\qquad - \frac{x_i^2 + [rx_i+(1-r)\mu]^2 - 2x_i[rx_i+(1-r)\mu]}{2(S+V)} \\ &= -\frac{(S+V)}{2SV}\Big(x_j - \frac{Vx_i + S[rx_i+(1-r)\mu]}{S+V}\Big)^2 - \frac{(1-r)^2(x_i-\mu)^2}{2(S+V)} \end{aligned}$$

Thus the expected similarity-based normative payoff of an individual with norm value x_i is

$$\begin{aligned} W_R(x_i) &= \int W_R\left(x_i|x_j\right)\phi(x_j)dx_j \\ &= \int \exp\left\{-\frac{(S+V)}{2SV}\Big(x_j - \frac{Vx_i + S[rx_i+(1-r)\mu]}{S+V}\Big)^2\right\}dx_j \\ &\qquad \times \exp\left\{- - \frac{(1-r)^2(x_i-\mu)^2}{2(S+V)}\right\} \\ &\propto \exp\left\{-\frac{(x_i-\mu)^2}{2\frac{(S+V)}{(1-r)^2}}\right\} \end{aligned} \tag{A.6}$$

Therefore, as assortment among interactants in normative effects increases, normative effects become weaker, and the population evolves to the optimum in direct effects more quickly (See *Appendix B* for the per-generation evolution). Intuitively, this happens because assortment means that individuals interact with others who are more similar to themselves and so reduces the cost of being different from the mean type.

4. Coordination in a larger group- normal distribution

Similarity-based normative interactions often occur between a focal individual and a larger group of partners. Assume individuals interact in groups with $n-1$ other members. In this section, we assume the focal individual's social payoff depends on how well her trait matches the average of the other group members, and that the norm does not impact how groups are formed or how well they perform. Let $y=(y_1,\ldots,y_{n-1})$ be the norm values of the $n-1$ other group members and $\tilde{y}=\frac{1}{n-1}\sum y_i$ be the average of the norm values of these other individuals. Then $\tilde{y}$ follows a normal distribution with mean $\mathrm{E}(\tilde{y}|x_i)=\mu$ and variance $\mathrm{Var}(\tilde{y}|x_i)=\frac{V}{n-1}$. If we follow the same procedures as above, it is easy to show

$$W_R(x_i)=\exp\left\{-\frac{(x_i-\mu)^2}{2\left(\frac{V}{n-1}+S\right)}\right\} \tag{A.7}$$

5. Coordination in a larger group formed with assortment with a group average optimum - normal distribution

Still assuming norm coordination is with all other group members, we now add the condition that the group performance depends on the average norm trait. Again, let $y=(y_1,\ldots,y_{n-1})$ be the norm values of the $n-1$ other group members and $\tilde{y}=\frac{1}{n-1}\sum y_i$, be the average of the norm values of these other individuals. The payoff to a focal individual with norm value x_i in this group is thus

$$W_R\left(x_i|\tilde{y}\right)=\exp\left\{-\frac{(x-\tilde{y})^2}{2S}-\frac{\left(\frac{1}{n}\left(x_i+(n-1)\tilde{y}\right)-\eta\right)^2}{2G}\right\} \tag{A.8}$$

where η is the optimal group average norm value in direct effects on group, and G indicates the tolerance of the group direct effects.

We assume that groups are formed with a constant assortment score r between any two members. Therefore, given x_i, $\tilde{y}$ follows a normal distribution with mean $\mathrm{E}(\tilde{y}|x_i)=rx+(1-r)\mu$ and and variance $\mathrm{Var}(\tilde{y}|x_i)=\frac{V}{n-1}\left(1+(n-2)r\right)$.

$$
\begin{aligned}
&W_R(x_i) \\
&= \int W_R\left(x_i|\tilde{y}\right)\phi(\tilde{y})d\tilde{y} \\
&= \frac{\sqrt{n-1}}{\sqrt{2\pi[1+(n-2)r]V}}\int \exp\left\{-\frac{(x_i-\tilde{y})^2}{2S}-\frac{\left[\frac{x_i+(n-1)\tilde{y}}{n}-\eta\right]^2}{2G}-\frac{(n-1)\left(\tilde{y}-[rx_i+(1-r)\mu]\right)^2}{2[1+(n-2)r]V}\right\}d\tilde{y} \\
&\propto \int \exp\left\{\frac{\begin{array}{r}\left\{[1+(n-2)r]GV+[1+(n-2)r]\left(\frac{n-1}{n}\right)^2SV+(n-1)SG\right\}\tilde{y}^2 \\ -2\left\{[1+(n-2)r]GVx_i+[1+(n-2)r]\frac{n-1}{n}SV(\eta-\frac{x_i}{n})+(n-1)SG\left[rx_i+(1-r)\mu\right]\right\}\tilde{y} \\ +\left[1+(n-2)r\right]GVx_i^2+\left[1+(n-2)r\right]SV(\eta-\frac{x_i}{n})^2+SG(n-1)\left[rx_i+(1-r)\mu\right]^2\end{array}}{2\left[1+(n-2)r\right]GSV}\right\}d\tilde{y} \\
&\propto \exp\left\{\frac{\begin{array}{r}\left\{[1+(n-2)r]GVx_i^2+[1+(n-2)r]SV(\eta-\frac{x_i}{n})^2+SG(n-1)\left[rx_i+(1-r)\mu\right]^2\right\} \\ \times\left\{[1+(n-2)r]GV+[1+(n-2)r]\left(\frac{n-1}{n}\right)^2SV+(n-1)SG\right\} \\ -\left\{[1+(n-2)r]GVx_i+[1+(n-2)r]\left(\frac{n-1}{n}\right)SV(\eta-\frac{x_i}{n})\right\}^2\end{array}}{2\left[1+(n-2)r\right]\left\{[1+(n-2)r]GV+[1+(n-2)r]\left(\frac{n-1}{n}\right)^2SV+(n-1)SG\right\}SGV}\right\} \\
&\propto \exp\left\{\frac{\begin{array}{r}\left\{[1+(n-2)r]V+(n-1)(1-r)^2G+\frac{(n-1)[1+(n-1)r]^2}{n^2}S\right\}x_i^2 \\ -2\left\{[1+(n-2)r]V\eta+(n-1)(1-r)^2G\mu+\frac{(n-1)}{n}\left[1+(n-1)r\right]S\eta-\left(\frac{n-1}{n}\right)^2\left[1+(n-1)r\right]S\mu\right\}x_i\end{array}}{2\left\{[1+(n-2)r]GV+[1+(n-2)r]\left(\frac{n-1}{n}\right)^2SV+(n-1)SG\right\}}\right\} \\
&\propto \exp\left\{\frac{\left(x_i-\frac{[1+(n-2)r]V\eta+(n-1)(1-r)^2G\mu+\frac{(n-1)}{n}[1+(n-1)r]S\eta-(\frac{n-1}{n})^2[1+(n-1)r](1-r)S\mu}{[1+(n-2)r]V+(n-1)(1-r)^2G+\frac{(n-1)[1+(n-1)r]^2}{n^2}S}\right)^2}{2\frac{[1+(n-2)r]GV+[1+(n-2)r](\frac{n-1}{n})^2SV+(n-1)SG}{[1+(n-2)r]V+(n-1)(1-r)^2G+\frac{(n-1)[1+(n-1)r]^2}{n^2}S}}\right\}
\end{aligned}
\tag{A.9}
$$

6. Two-person coordination with moral belief

When the prevalent moral belief has a partner j prefer the norm trait of i to be δ above her own, the social payoff from the pairwise interaction is:

$$
W_R(x_i|x_j) = \exp\left\{-\frac{\left[x_i-(x_j+\delta)\right]^2}{2S}\right\} \tag{A.10}
$$

Again, assume normal distribution of normative traits, so

$$
W_R(x_i|x)\phi\left(x\right) = \frac{1}{\sqrt{2\pi V}}\exp\left\{-\frac{\left[x_i-(x+\delta)\right]^2}{2S}-\frac{\left(x-\mu\right)^2}{2V}\right\}
$$

Now expand the exponent, Z, and complete the square

$$\begin{aligned} Z &= -\frac{V\left[(x_i-\delta)^2 - 2(x_i-\delta)x + x^2\right] + S\left(x^2 - 2\mu x + \mu^2\right)}{2SV} \\ &= -\frac{(V+S)\,x^2 - 2\left[V(x_i-\delta) + S\mu\right]x + V(x_i-\delta)^2 + S\mu^2}{2SV} \\ &= -\left(\frac{S+V}{2SV}\right)\left[x - \frac{V(x_i-\delta)+S\mu}{S+V}\right]^2 - \frac{(x_i-\delta-\mu)^2}{2(S+V)} \end{aligned}$$

The distribution-reliant total payoff of norm value x_i is thus

$$\begin{aligned} W_R(x_i) &= \int W_R(x_i|x)\phi\left(x\right)dx \\ &= \frac{1}{\sqrt{2\pi V}}\exp\left\{-\frac{(x_i-\delta-\mu)^2}{2(S+V)}\right\}\int \exp\left\{-\frac{\left[x - \frac{V(x_i-\delta)+S\mu}{S+V}\right]^2}{2\frac{SV}{S+V}}\right\}dx \\ &= \frac{1}{\sqrt{2\pi V}}\exp\left\{-\frac{(x_i-\delta-\mu)^2}{2(S+V)}\right\}\sqrt{2\pi\frac{SV}{S+V}} \\ &= \sqrt{\frac{S}{S+V}}\exp\left\{-\frac{(x_i-\delta-\mu)^2}{2(S+V)}\right\} \\ &\propto \exp\left\{-\frac{(x_i-\delta-\mu)^2}{2(S+V)}\right\} \end{aligned} \tag{A.11}$$

Evolutionary Process

Table 9 offers a summary of the parameters that appear in the base model and different extensions.

1. The per-generation evolution

In the previous section, Ii have calculated the expected distribution-reliant payoff of x_i, $W_R(x_i)$, under different conditions. When there are no direct effects based on the group's average norm $W_R(x_i) = W_S(x_i)$, the similarity-based normative payoff; when there are group direct effects, x_i's distribution-reliant payoff is the product of her expected similarity-based normative payoff and her expected payoff in group direct effects, such that $W_R(x_i) = W_S(x_i) \times W_G(x_i)$.

From Eqs. (A.3), (A.5) to (A.7), (A.9) and (A.11), we can see that $W_R(x_i)$ always takes the Gaussian form, so we can represent them with the generic expression $W_R(x_i) = \exp\left\{-\frac{(x_i-\tau)^2}{2T}\right\}$. (See Table 10 for the values of τ and T in each condition. The conditions in row 2 to row 6 correspond to part 2 to part 6 in the previous section,

Table 9. Parameters and Their Biological Meanings

parameter	biological meaning
μ_t	population mean norm at generation t
V_t	population norm value distribution variance at generation t
S	tolerance of similarity-based normative effects
η	optimal group average norm in group direct effects
G	tolerance of direct effects on group
r	assortment coefficient
δ	preferred deviation in normative effects
θ	optimal individual norm value in individual direct effects
D	tolerance of direct effects on individual

respectively.) Other than the distribution-reliant payoff $W_R(x_i)$, individual i with norm trait value x_i experiences direct effects and receives payoff $W_D(x_i) = \exp\left\{-\frac{(x_i-\theta)^2}{2D}\right\}$. The optimum in individual direct effects, θ, is constant, and $W_D(x_i)$ does not depend on the population distribution.

Table 10. Parameter Values in Different Contexts

context	τ	T
2-person interaction	μ_t	$V_t + S$
2-person assorted	μ_t	$\frac{V_t+S}{(1-r)^2}$
Group of n	μ_t	$\frac{V_t}{n-1} + S$
Group of n with group direct effects	$\frac{[1+(n-2)r]V_t\eta+(n-1)(1-r)^2G\mu_t}{[1+(n-2)r]V_t+(n-1)(1-r)^2G+\frac{(n-1)[1+(n-1)r]^2}{n^2}S} + \frac{\frac{(n-1)}{n}[1+(n-1)r]S\eta-(\frac{n-1}{n})^2[1+(n-1)r]S\mu_t}{[1+(n-2)r]V_t+(n-1)(1-r)^2G+\frac{(n-1)[1+(n-1)r]^2}{n^2}S}$	$\frac{[1+(n-2)r]GV_t+[1+(n-2)r](\frac{n-1}{n})^2SV_t+(n-1)SG}{[1+(n-2)r]V_t+(n-1)(1-r)^2G+\frac{(n-1)[1+(n-1)r]^2}{n^2}S}$
Preferred deviation	$\mu_t + \delta$	$V_t + S$

With the distribution-reliant payoff $W_R(x_i)$ and the individual direct payoff $W_D(x_i)$,

we solve for how the population's norm value distribution changes from generation t to generation $t+1$. We then solve for the population's equilibrium distribution.

The aggregated payoff of x_i from all effects, $W(x_i)$, is given by $W(x_i) = W_R(x_i) \times W_D(x_i)$. The distribution of social learning models accounting for their payoffs is thus

$$\phi\prime\,(x) = \frac{W(x)\phi(x)}{\int W(x)\phi(x)dx} \tag{A.12}$$

where

$$W(x)\phi(x) = \exp\left\{\frac{(x-\tau)^2}{2T} - -\frac{(x-\theta)^2}{2D} - \frac{(x-\mu)^2}{2V}\right\} \tag{A.13}$$

We follow the same procedure of expanding the exponent Z and completing the square.

$$\begin{aligned}
Z &= -\frac{(x-\tau)^2}{2T} - \frac{(x-\theta)^2}{2D} - \frac{(x-\mu)^2}{2V} \\
&= \frac{-TV\left(x^2-2\theta x+\theta^2\right) - DV\left(x^2-2\tau x+\tau^2\right) - DT\left(x^2-2\mu x+\mu^2\right)}{2DVT} \\
&= -\frac{(TV+DV+DT)x^2 - 2(TV\theta+DV\tau+DT\mu)x + TV\theta^2+DV\tau^2+DT\mu^2}{2DVT} \\
&= -\left(\frac{TV+DV+DT}{2DVT}\right)\left[x^2 - 2x\left(\frac{TV\theta+DV\tau+DT\mu}{TV+DV+DT}\right) + \left(\frac{TV\theta^2+DV\tau^2+DT\mu^2}{TV+DV+DT}\right)\right] \\
&= -\left(\frac{TV+DV+DT}{2DVT}\right)\left[x - \left(\frac{TV\theta+DV\tau+DT\mu}{TV+DV+DT}\right)\right]^2 \\
&\qquad + \left[\frac{(TV\theta+DV\tau+DT\mu)^2 - (TV\theta^2+DV\tau^2+DT\mu^2)(TV+DV+DT)}{2DVT(TV+DV+DT)}\right]
\end{aligned}$$

Therefore, the distribution of social learning models in generation t transformed by their payoffs is:

$$\phi'\,(x) = \frac{\sqrt{TV+DV+DT}}{\sqrt{2\pi DVT}} \exp\left[-\frac{x - \left(\frac{TV\theta+DV\tau+DT\mu}{TV+DV+DT}\right)}{\frac{2DVT}{TV+DV+DT}}\right]^2$$

which is the density function of a normal distribution $X' \sim N(\mu', V')$ with

$$\mu' = \frac{TV\theta+DV\tau+DT\mu}{TV+DV+DT}$$
$$V' = \frac{DVT}{TV+DV+DT}$$

After the individuals from the current generation receive their payoffs, they pass down their traits to naive individuals in the next generation with probability proportional to their payoffs. When naive individuals sample $k > 1$ models and attempt to learn the models' average, and unbiased social learning error that follows $N(0, E)$, the next generation's norm value distribution follows a normal distribution $X_{t+1} \sim N(\mu_{t+1}, V_{t+1})$ with

$$\mu_{t+1} = \frac{TV_t\theta + DV_t\tau + DT\mu_t}{TV_t + DV_t + DT}$$
$$V_{t+1} = \frac{DV_tT}{k(TV_t + DV_t + DT)} + E$$

when the population's norm trait distribution at generation t is $X_t \sim N(\mu_t, V_t)$.

At equilibrium, we have $\mu_{t+1} = \mu_t$ and $V_{t+1} = V_t$. The equilibrium variance does not depend on the mean, but the equilibrium mean depends on the equilibrium variance.

2. Equilibrium variance is unique and stable

Here we prove using the base model as an example that the population norm value distribution's variance reaches a unique stable equilibrium. The recursion for the variance is:

$$V_{t+1} = \frac{DS + DV_t}{SV_t + V_t^2 + DS + 2DV_t}V_t + E \tag{A.14}$$

This recursion does not depend on μ_t so the variance will evolve independently. Here we prove that this recursion has a unique, stable equlibrium for positive values of V_t.

First note that if $V_t = 0$, then $V_{t+1} = E$. Second, as $V_t \to \infty$ the $V_{t+1} \to D+E > E$. Next, compute the derivative of V_{t+1} as a function of V_t. Let

$$T = DSV_t + DV_t^2$$

and

$$B = V_t^2 + (2D + S)V_t + DS$$

Then

$$\frac{dV_{t+1}}{dV_t} = \frac{(DS + 2D)B - (((2D + S) + 2V_T)\,T}{B^2}$$

Thus the sign of the derivative is determined by the numerator.

$$\begin{aligned}
B^2\frac{dV_{t+1}}{dV_t} &= (DS+2D)(V_t^2+(2D+S)V_t+DS) \\
&\quad -(((2D+S)+2V_T)(V_t^2+(2D+S)V_t+DS) \\
&= DS(2d+S)V_t+DSV_t^2+ \\
&\quad (DS)^2+2DV_t^3+V_t^2 2D(2D+S)+2DSV_t \\
&\quad -2DSV_t^2-2DV_t^3-(2D+S)DSV_t-(2D+S)DV_t^2 \\
&= V_t^3(2D-2D)+V_t^2(DS+2D(2D+S)-2DS-D(2D+S)) \\
&\quad V_t(DS(2D+S)+2DS-(DS(2D+S))+(DS)^2) \\
&= 2D^2V_t^2+2DSV_t+(DS)^2>0
\end{aligned}$$

Since $V_{t+1}=E$ when $V_t=0$ and $V_{t+1}\to D+E>E$ as $V_t\to\infty$ and $\frac{dV_{t+1}}{dV_t}>0$ for all V_t it follows that the recursion intersects the line $V_{t+1}=V_t$ only once and at that point it has a positive slope less than 1. Thus there is a single equilibrium and it is asymptotically stable.

3. Equilibrium mean norm

Given that the equilibrium variance is unique and stable, we can represent the equilibrium mean norm as a function of the parameters that define the context, and the equilibrium distribution variance $\hat{V}$ (Table 11).

Table 11. Equilibrium Mean Norm Values in Different Contexts

context	equilibrium mean norm
2-person interaction	θ
2-person assorted	θ
Group of n	θ
Group of n with group direct effects	$\frac{\left\{[1+(n-2)r]GV+[1+(n-2)r](\frac{n-1}{n})^2SV+(n-1)SG\right\}\theta+\left\{[1+(n-2)r]DV+\frac{n-1}{n}[1+(n-1)r]DS\right\}\eta}{[1+(n-2)r]GV+[1+(n-2)r](\frac{n-1}{n})^2SV+(n-1)SG+[1+(n-2)r]DV+\frac{n-1}{n}[1+(n-1)r]DS}$
Preferred deviation	$\theta+\frac{D}{V+S}\delta$

When there are similarity-based normative effects, direct effects on individual, and direct effects on group, S, the tolerance of similarity-based normative effects can

impact the equilibrium mean norm unless it happens after the two effects. This is because similarity-based normative effects change the population variance and thus impact the relative strength of individual direct effects vs. group direct effects.

APPENDIX B

SAMPLE INTERVIEW ON REAL-LIFE CO-FARMING PARTNERSHIPS

Subject ID: SB56721
Survey Date: 2020/11/27

General Farming Conditions

Q1. Do you have just enough subsistence crop harvests (e.g., potatoes, corn) for your household, more than enough that you cannot consume them all before they rot, or not enough subsistence crop harvests?
A1: There is not enough corn, because need to feed chickens and pigs. There are more potatoes harvested than we can eat.

Q2. Do you feel your household is in shortage of land (farming land or forest land)? (If subject answered yes) How much more would you like to have? In what location?
A2: There is no shortage of fixed land, and there is no shortage of forest land.

Q3. Is subsistence crop farming important to your household? (If you switch to farming all cash crops like RHIZOMA PARIDIS instead and purchasing your grains, will you like it better, like is less, or feel indifferent?)
A3: It is better to grow a little subsistence crops. If (we) don't farm, there is nothing to eat. As for buying food, you may not be able to buy it at all times.

Q4. Is farming important to your household? (If you quit farming and switch to earning incomes by going outside to work waged jobs or accommodating tourists, will you like it better, like it less, or feel indifferent?)
A4: It is better to farm a bit of land. The store is mainly for convenience (instead of relying on it as the income source).

Q5. Do you feel your household has enough labor for farming?
A5: There is a shortage. There are only two laborers in my household. It would be enough if there are 2 more.

Current Co-farming

Q6. Who are you cofarming with? What plant are your cofarming?
A6: 1) LD190718: SB38624's land in LM pasture, about 1 mu, SB38624 and SB72049 (SB56721's husband) two households cofarming corn and potato; 2) LD838648: Gongqian communal land, 1 Mu, SB56721 and SB74798 two households CF potatoes and corn;

Q7. When did you first start this co-farming partnership? Have you been farming together every year since then?
A7: 2) 2019

Q8. Why are you farming cooperatively with others?
A8: 2) Because of the lack of labor force in my own household. At the beginning it is difficult to dig the land. It took a week to dig out the stones. At that time,

SB74798's household, SB74798 and SB50131 two laborers went together; for SB56721's household, the SB56721 couple went.

Q9. Who proposed to cofarm? (If subject) Why did you select this partner?
A9: 2) Proposed by SB56721. SB74798 has less land, and those with more land may not have the time to CF with us.

Q10. How are you benefiting from this cofarming?

Q11. How many laborers does each family provide? Who provides the land? Who provides how much seeds, fertilizers, land membranes, etc.?
A11: 2) In 2019, the seeds were contributed by the two households together, and both contributed the same amount. Which household contributed the land membranes and the fertilizers depended on which household had them, because we are all family. The deceased husband of SB74798 and SB72049's father are full brothers. In 2019, the SB56721 household always went 2 people, and the SB74798 family went 2 people. In 2020, each household contributed about 5 Jin of land membranes, and each household contributed about 15 Jin of chemical fertilizers. In 2020, the SB56721 household went 2 people every time. The SB74798 household, SB74798 went every time, SB73069 and SB37757 went to help every time. SB50131 (SB74798's son) and his wife also went during planting; To return the favor of SB73069 and SB37757, the SB56721 couple went when digging potatoes. The other times, SB74798 returned the favor by herself. Overall, the SB74798 household worked more, because they had more helpers, and our household (the laborers were) only us couple.

Q12. How much of each kind of crop did you harvest? How much of each kind of crop did each family get in division?
A12: 2) There are 5 baskets of mature corn, 1 basket of fresh corn. Each household got divided 2 baskets of mature corn. One basket was made into corn flakes and then divided equally, each household got about 10 Jin (of corn flakes). Other than what the two CF households got, gave the SB73069 household 5 Jin of corn flakes, and gave the SB37757 household 5 Jin of corn flakes. Only gave the helpers corn flakes, not corn on cobs. Each CF household received 2 baskets of potatoes, did not gift to helpers, because all households have potatoes, no need to gift it.

Q13. Did you and your partner(s) discuss how you would divide before you decided to cofarm? Did you and your partner(s) discuss which household should contribute how many laborers, or what counts as a household? How did you discuss it? (If household is defined differently from residential pattern) Why did you define a household in this way?
A13: 2) No discussion before or after harvest; No discussion about how many labors each household would contribute.

Q14. Has the division rule changed during the years of your cofarming with this partner?

Q15. Are there alternative ways of division that you think are more reasonable? (Will you like it better if you and your current cofarming partners track attendance and divide in proportion to labor contribution? Why?/Why not?)

A15: 2) It is more reasonable for SB74798's household to get divided more for contributing more laborers, I proposed but SB74798 did not agree.

Q16. In this year or past years, have you ever felt your household is not making as much contribution to the co-farming as your partner(s)? (If subject answered yes) Is that an issue to you? Have you proposed ways to make up for that?

Q17. Has/Have your partner(s) ever complained about your household not making enough contribution?

Q18. In this year or past years, have you ever felt the other household(s) is/are not making as much contribution as your household? (If subject answered yes) Have you told the other household? Have you or the other household proposed ways to make up for that?

Q19. Have you ever complained to others about your co-farming partner(s)' household(s) not making enough contribution?

Q20. If you propose (alternative division), how do you think your partner will respond behaviorally and emotionally? (Will they get upset? Will they complain about your behavior to other people? Is it possible for them to end the cofarming relationship with you because of this?)

Q21. If other people in the village hear about your above behavior (note to URAs: proposing to divide in the way specified in Q20) how do you think they will react to that behaviorally and emotionally? (Will they think you are petty, selfish, or bad-hearted? Is it possible for they to be unwilling to co-farm with you in the future when you wish to cofarm with them?)

Q22. If your partner proposes (alternative division), how will you react to that behaviorally and emotionally? (Will you get upset? Will you complain to others? Is it possible for you to end the cofarming relationship with them because of this?)

Co-farming Notions Rejected

Q23. Has it ever happened that you proposed to farm together with others but they did not agree? List as many of such cases as you can remember. (If yes, for each such case ask the following set of questions: When did it happen? Who was it that you asked to cofarm with? Why did you want to cofarm with them? What was the reason they gave you for not being able to cofarm with you?)
A23: No.

Q24. Has it ever happened that other people proposed to cofarm with you but you could not agree? List as many of such cases as you can remember. (If yes, for each such case ask the following set of questions: When did it happen? Who proposed it? Why couldn't you cofarm with them? (If the subject rejected some but accepted some others) Why did you agree to cofarm with (some other's name) but not the above mentioned people?)
A24: No.

Past Cofarming

Q25. Did you participate in co-farming that happened in the past and has already ended? Was there cofarming that ended before any harvest? (If yes, for each such case ask the following set of questions: Who did you cofarm with? When did it start? When did it end? What did you farm? Who provided the land? What was the area of the land? How many laborers did each household provide? How many seeds, fertilizers, membranes did each household provide? How did you divide each kind of crop you farmed together? Why did the cofarming partnership stop?)
A25: No.

Future Cofarming

Q26. Do you have the intention to do (more) cofarming? (It could be subsistence crops or cash crops, on farming land or forest land)
A26: No, there are only two laborers in my family and we cannot finish that much work.

Q27. (If answered yes in Q26) What kind of partner do you want? (number of laborers, area of land, land position, personality, economic capability, etc.?)

Normative Knowledge

Q28. Do you know how other households in village D divide when they farm subsistence crops? If so, how do they divide?
A28: Don't know. It is probably divided equally; even if the labor, land, and seed contribution are not the same, it is still divided equally, because (the people in village D) are not so calculating.

Q29. Do you know how other households in village D divide when they farm cash crops? If so, how do they divide?
A29: The CF of cash crops may be divided in proportion to the number of labors. If it is not organized by the government, but the people themselves want to CF, it may be divided equally, no matter who contributes more labor and land.

APPENDIX C

IRB PERMITS

APPROVAL: MODIFICATION

Sarah Mathew
CLAS-SS: Human Evolution and Social Change, School of (SHESC)
480/965-3468
Sarah.Mathew@asu.edu

Dear Sarah Mathew:

On 6/3/2020 the ASU IRB reviewed the following protocol:

Type of Review:	Modification / Update
Title:	Documentation of norms and norm shift dynamics in Dulong people (Yunnan, China)
Investigator:	Sarah Mathew
IRB ID:	STUDY00008145
Funding:	Name: NSF: Directorate for Social, Behavioral & Economic Science (SBE), Grant Office ID: FP00023202; Name: Max Planck Institute for Evolutionary Anthropology
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Form-translation-certificate 06032020.pdf, Category: Other; • HRP-502a - ConsentFormForHouseholdLeaders-2020 English.pdf, Category: Consent Form; • HRP-502a - ConsentFormForHouseholdLeaders-2020-Chinese .pdf, Category: Consent Form; • HRP-502a - ConsentFormForMinors-2020.pdf, Category: Consent Form; • HRP-502a - ConsentFormForMinors-2020-Chinese.pdf, Category: Consent Form; • HRP-502a - ConsentFormForParents-2020.pdf, Category: Consent Form; • HRP-502a - ConsentFormForParents-2020-Chinese.pdf, Category: Consent Form; • HRP-503a-NormShiftStudyInDulong2020.docx, Category: IRB Protocol;

	• NSF proposal.pdf, Category: Sponsor Attachment; • verbal-script2020.pdf, Category: Recruitment Materials;

The IRB approved the modification.

When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Minhua Yan
Minhua Yan

APPENDIX D

LOCAL GOVERNMENT PERMIT

ASU School of Human Evolution and Social Change
Arizona State University

April 25, 2018

The People's Government of Gongshan (贡山县人民政府)
Yunan Province
People's Republic of China

Re: Minhua Yan

贡山县人民政府：

兹证明严敏华系 亚利桑那州立大学 人类进化与社会发展学院 进化人类学专业博士生，她将于贡山县内开展题为《传承与发展：独龙族的文化与习俗变迁》的人类学研究课题，该课题系其博士学位要求的一部分，并对贡山县民族文化人类学科的研究有重要意义。我系对此课题全力支持，请贵单位给予接洽为谢。

如有疑问，请与我系联系。

院长签字：Kaye E. Reed
Kaye E. Reed, President's Professor
Director, School of Human Evolution and Social Change

单位盖章：School of Human Evolution and Social Change
APR 25 2018
Arizona State University

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