Historically Rice-Farming Societies Have Tighter Social Norms in China and Worldwide

Thomas Talhelm
University of Chicago Booth School of Business

Alexander S. English
Shanghai Intercultural Institute, Shanghai International Studies University

Author Note
This research was supported by a William Ladany Fellowship awarded to Thomas Talhelm.

Correspondence about this article should be addressed to Thomas Talhelm, University of Chicago Booth School of Business, 5807 South Woodlawn Avenue, Chicago, IL 60637.
Email: Thomas.Talhelm@ChicagoBooth.edu

Condensed Title for Mobile/RSS (50 characters including spaces): Historical Rice Farming Predicts Tight Norms
Abstract

Data recently published in *PNAS* mapped out regional differences in the tightness of social norms across China. Norms were tighter in developed, urbanized areas and weaker in rural areas. We tested whether historical paddy rice farming has left a legacy on social norms in modern China. Pre-modern rice farming could plausibly create strong social norms because paddy rice relied on irrigation networks. Rice farmers coordinated their water use and kept track of each person’s labor contributions. Rice villages also established strong norms of reciprocity to cope with labor demands that were twice as high as dryland crops like wheat. In line with this theory, China's historically rice-farming areas had tighter social norms than wheat-farming areas, even beyond differences in development and urbanization. Rice-wheat differences were just as large among people in 10 neighboring provinces (*N* = 3,835) along the rice-wheat border. These neighboring provinces differ sharply in rice and wheat, but little in latitude, temperature, and other potential confounding variables. Outside of China, rice farming predicted norm tightness in 32 countries around the world. Finally, people in rice-farming areas scored lower on innovative thinking, which tends to be lower in societies with tight norms. This natural test case within China might explain why East Asia—historically reliant on rice farming—has tighter social norms than the wheat-farming West.

*Keywords*: tightness-looseness, social norms, rice theory, agriculture, subsistence style
RICE FARMING PREDICTS TIGHT NORMS

Significance Statement

Rice is a highly interdependent crop. Rice required far more labor than dryland crops like wheat, and rice's irrigation networks forced farmers to coordinate water use. To deal with these demands, rice villages developed strong norms for labor exchange.

Using China as a natural test case, we compare nearby provinces that differ in rice and wheat but share the same ethnicity, religion, and national government. In survey data from over 11,000 Chinese citizens, rice-farming provinces report tighter norms than traditionally wheat-growing provinces. Rice also predicts tight norms around the world. This data suggests that China’s agricultural past still shapes cultural differences in the modern day—and perhaps why East Asia has tighter social norms than the wheat-growing West.
RICE FARMING PREDICTS TIGHT NORMS

Historically Rice-Farming Societies Have Tighter Social Norms in China and Worldwide

Social norms give structure to human societies—what it's OK to do; what's offensive; and we're morally obligated to do. All societies have norms, but when psychologists surveyed people in 32 nations around the world, they found that nations differed widely in the strength of those norms (1). In nations like India and South Korea, they found tight norms and low tolerance for deviation from accepted behavior. In nations like Israel and Venezuela, they found looser norms and more tolerance for non-conformists.

Tight norms seem to have consequences for people's psychology. For example, people in societies with tight norms are better at self-monitoring but also less creative (1–3). Here we look not at the consequences of tight norms, but rather the question of where these norms come from. Researchers have found that norm differences across societies map onto factors like religion, urbanization, and disease (1–4). We ask whether histories of farming influence which cultures are tight and which are loose, even in places where farming is no longer a part of most people's everyday life.

To get at this question, we leverage a natural test case. We compare regions in China that share the same national government, ethnicity, and language, yet differ in a variable that researchers have not tested as a cause of norm tightness—rice farming. First, we sketch out why the process of growing rice could plausibly leave a legacy of tight norms. We contrast rice with wheat, one of China's other major historical grain crops. Although rice and wheat are both staples in China, we sketch out the reasons why wheat would allow for looser norms than rice.
RICE FARMING PREDICTS TIGHT NORMS

We use China as a natural experiment, but the implications are not limited to China. If rice farming shapes culture, the consequences would extend to over half of the world's population. Slightly more than 50% of the people in the world live in nations with a significant portion of wetland rice farming (5). Thus, after testing for differences in China, we test whether rice farming can explain norm tightness around the world.

Norm Tightness in China

To measure norm tightness around China, we draw on a recent study in *PNAS* (2). In the study, researchers mapped out regional differences by surveying 11,662 people across China. They found stronger social norms in cities and highly developed provinces like Shanghai. Norms were weaker in less developed, rural provinces. For example, people in Shanghai were more likely than people from rural provinces to agree with statements like, “People agree upon what behaviors are appropriate versus inappropriate in most situations.”

Norms were also stronger in provinces that had experienced more threats. For example, norms were stronger in provinces that had higher rates of disease (Table S5 from 2), territorial occupation during World War II, and environmental disasters like chemical leaks and oil spills (p. 2). In contrast, norms tended to be weaker in provinces that were more remote, farther from the central government in Beijing (p. 2). Among all the different factors, the authors flagged urbanization as a "key factor" in explaining which provinces had tighter norms.

Why Rice Might Have Shaped Norms

China's urban-rural divide is stark, but it is not the only cultural dividing line in China. The dividing line between rice and wheat cuts across the middle of China, near the Yangtze River. Around the Yangtze River and farther south, people have
RICE FARMING PREDICTS TIGHT NORMS

been farming rice for generations. Farther north, people have been farming dryland crops like wheat and millet.

Rice is a starkly different crop from wheat. Pre-modern paddy rice required twice the labor hours per hectare as crops like wheat, corn, and potatoes (6–8). Rice farming was more work because it involved tasks that wheat did not. For example, wheat farmers planted seeds directly in the field, but paddy rice farmed first planted seeds in small seedbeds (so that they could tightly control water levels) then later transplanted them to the field. What's more, rice farmers completed these tasks in wet, muddy fields, which made even the same tasks take longer (7).

To deal with these demands, rice farmers exchanged labor. Far from a China phenomenon, labor exchange was common to rice around the world. Anthropologists have observed labor exchange customs in rice villages from Japan to West Africa (7–9).

Of course, rice farmers are not the only people in the world who help each other. Wheat farmers help each other too. Yet the exchange is different. For example, one anthropologist compared labor exchange among dryland farmers in the Congo and rice farmers in Japan (10). Both groups exchanged labor, but the exchange of labor in rice areas was more critical and binding, whereas the exchange in the dryland areas was looser and more "festive" (10).

According to an anthropologist living in a Chinese rice village, if households "for any reason" can't repay the labor they accept, they "must" hire workers to return the favor (11). Hiring laborers was expensive and inefficient, since paid laborers produced "careless work" and caused "wastage of grain" (11). The fact that farmers would use such a costly method signals just how strong norms were for labor exchange.
RICE FARMING PREDICTS TIGHT NORMS

In short, rice villages had strong norms for reciprocity (7). If reciprocity really traces back to rice, it might be a factor that contributes to explaining modern-day differences in social ties across cultures. For example, asking people in Korea (a rice-farming culture) to think about how another person helped them triggered feelings of indebtedness, but it had no such effect on Americans (12).

**Rice Irrigation Relied on Norms**

Another fundamental difference between rice and wheat is that paddy rice grows in standing water. By managing water levels, farmers can get yields four times larger than dryland rice (13). To get those yields, farmers needed irrigation systems. Those systems were not just engineering projects. They were social projects that profoundly shaped rice villages.

Contrast this with wheat villages, which often relied on rainfall. In those wheat villages, the weather coordinated the water. But when farmers came to control water, they had to start coordinating who got water. In some villages, the irrigation networks forced farmers to flood and drain their fields at the same time (8). If rice farmers disagreed about when to flood their fields, farmers who believed in early flooding would bicker with farmers who believed in later flooding. Ultimately someone would have to win the argument, because the irrigation network gave them no choice.

Farmers linked together in irrigation systems also had to coordinate the work of dredging and repairing the channels (8, 9). It would have been difficult to coordinate that work in a society that had lots of people with their own ideas. An anthropologist in China found that everyone in the rice village he observed "can give, without hesitation" the arrangement of tasks from seed to harvest (11). Even a child recited "the complete annual agricultural cycle without omission or deviation from the
RICE FARMING PREDICTS TIGHT NORMS

proper order." These shared norms make sense as adaptations to help rice farmers coordinate their shared irrigation networks.

Beyond timing, farmers also needed to coordinate the labor needed to repair and dredge the irrigation channels every year (14). So rather than allowing for individual differences, rice farmers set up systems to assign chores and monitor each other’s contributions. For example, rice farmers near Shanghai kept track of each person’s work assignments and punished people who failed to show up (9).

If farmers failed to fit in, punishments could cut deep. In Japan, rice farmers excluded uncooperative farmers from social life through *mura hachibu*, “80% separation from the village” (7). This legacy of strong norms might explain why people in modern-day Japan are more sensitive to social rejection than people in Western countries (15). It might also explain Japanese culture's push to "not offend others," as one cultural psychologist put it (16).

**Collectivism Does Not Always Require Coordination**

Prior studies have found evidence that rice cultures are more collectivistic (5, 17) and that collectivistic societies tend to have tighter norms $r = 0.49, P = 0.01$ (Table S2, 1). Thus, we could predict that rice cultures have tighter norms simply because they are more collectivistic. But this is a rather vague causal story. We argue that understanding the details of how people farmed rice produces more concrete reasons for how rice farming created tight norms.

Unpacking the specifics of rice farming can also be illuminating because it reveals what rice is *not*. Collectivism is a big concept. It encompasses multiple sub-facets. For example, researchers have identified sub-facets such as harmony, relying on other people, and being flexible to the situation (as opposed to being consistent across situations, 18).
Yet rice farming would more plausibly cause some of these traits than others. For example, one study found that people from rice-farming areas of China were more likely than people from wheat areas to suspect that other people—even coworkers and classmates—were secretly trying to undermine them (19). Rice farming involves collectivism, but we predict that it does not require feeling warm, loving feelings toward others (7).

Similarly, interdependence does not always require coordination. One analogy is the difference social scientists have found between baseball and basketball (20, 21). Both sports make individual players interdependent. Single players can usually only win if their teammates do well. Even if Barry Bonds could hit a homerun every time he came to the plate, he still wouldn't win if his pitchers were terrible. Thus, both baseball and basketball players are interdependent in a way that tennis players and sprinters are not.

Yet researchers have found evidence that baseball "depends far less on coordination" (21). Barry Bonds hit those homeruns (mostly) by himself, without coordinating with his teammates. But as great as Michael Jordan was, his scoring depended much more than Bonds' on blocks and passes from his teammates. Thus, while both sports are interdependent, basketball requires more coordination.

Coordination is clearly evident in traditional rice farming.

**Rice Versus Modernization**

When testing for causes of norm tightness, we compare rice to causes that the previous study in China found—economic development and urbanization (2). We also go beyond the prior study by testing *historical* urbanization and economic development. This is important because research has found a lag between economic
RICE FARMING PREDICTS TIGHT NORMS

development and cultural change (22). Historical environments are sometimes a stronger predictor of cultural differences than current conditions (1, 23).

Finally, we expand on the prior study by testing indicators of economic modernization beyond GDP. This is valuable because modernization theorists have argued that GDP is not the best marker of modernization (24, 25). Instead, researchers have argued that education or the shift to the modern service economy are better indicators of modernization (25). In China, the shift from the state-run economy to the private sector may be another important indicator of modernization. Thus, we analyze data on private industry, the service economy, and education (again, testing both modern and historical indicators).

**Does Urbanization Lead to Stronger Norms in China, But Not in the US?**

The results replicated the prior finding that social norms are tighter in more developed provinces, $\gamma = 0.32$, $P < 0.001$, $r_{prov} = 0.59$ ($\gamma$ represents group-level regression coefficients). Yet we dug deeper on a surprising result from the prior study—that Chinese cities have tighter norms than rural areas. This is surprising because a study in the US found that cities have weaker norms (3). Another reason it is surprising is because studies have found that people in cities tend to be more creative (26), which is more common in areas with loose norms (1). Cities also tend to be more individualistic (27), which again is associated with loose norms (1). If true, the prior finding raises the intriguing possibility that urbanization somehow works differently in China than other places (28).

But after accounting for GDP, the paradoxical finding reversed (Table 1). Urbanization now predicted less strong norms ($\gamma = -0.01$, $P = 0.002$, $r_{prov} = -0.37$). When comparing places in China that are similarly wealthy, urbanized areas tend to
RICE FARMING PREDICTS TIGHT NORMS

have looser norms. Thus, the paradoxical finding seems to have been a confound of economic development.

**Rice Areas Have Tighter Social Norms**

Rice-farming areas had tighter social norms in a simple analysis ($\gamma = 0.10, P = 0.043, r_{prov} = 0.20$) and after taking into account GDP and urbanization ($\gamma = 0.12, P = 0.005, r_{prov} = 0.33$, Fig. 1, Table 1). Rice was robust to controlling for respondents’ age and education (Table 1, SI Appendix Table S6). Rice remained significant after taking into account the three different rounds of the survey, which stretched across three years.

Economic development explained the most variation in norm tightness ($r_{prov} = 0.59$). Rice ($r_{prov} = 0.33$) explained about as much variation as urbanization ($r_{prov} = .37$). In sum, both modern development and historical rice farming predicted patterns of norm strength across China.
Figure 1. Rice-farming provinces in China have tighter social norms (top). Around the world, societies that practiced more interdependent subsistence styles had tighter norms. This index accounts for land devoted to wheat, herding (less interdependent), and rice (more interdependent). Province scores control for urbanization and GDP.
RICE FARMING PREDICTS TIGHT NORMS

Table 1
Rice-Farming Provinces Have Tighter Social Norms

|                        | B/γ  | SE  | t     | P    |
|------------------------|------|-----|-------|------|
| **Rice**               |      |     |       |      |
| Male                   | 0.001| 0.012| 0.06  | 0.953|
| Age                    | 0.001| 0.001| 1.90  | 0.058|
| GDP per Capita         | 0.32 | 0.06 | 5.72  | < 0.001|
| % Urban                | -0.76| 0.23 | -3.27 | 0.002|
| % Cultivated Land      | 0.14 | 0.11 | 1.35  | 0.181|
| % Rice                 | 0.12 | 0.04 | 2.90  | 0.005|
| **Rice Suitability**   |      |     |       |      |
| Male                   | 0.001| 0.012| 0.05  | 0.959|
| Age                    | 0.001| 0.001| 1.89  | 0.058|
| GDP per Capita         | 0.33 | 0.06 | 5.66  | < 0.001|
| % Urban                | -0.69| 0.23 | -3.01 | 0.003|
| % Cultivated Land      | 0.07 | 0.11 | 0.66  | 0.514|
| Environ. Rice Suitability | 0.001 | 0.001 | 2.60 | 0.011 |
| **Rice-Wheat Border**  |      |     |       |      |
| Male                   | 0.01 | 0.02 | 0.43  | 0.666|
| Age                    | 0.002| 0.001| 2.12  | 0.034|
| GDP per Capita         | 0.33 | 0.13 | 2.62  | 0.016|
| % Urban                | -1.04| 0.60 | -1.73 | 0.098|
| % Cultivated Land      | 0.09 | 0.19 | 0.48  | 0.640|
| % Rice                 | 0.21 | 0.09 | 2.20  | 0.040|
| **Herding**            |      |     |       |      |
| Male                   | 0.001| 0.012| 0.06  | 0.951|
| Age                    | 0.001| 0.001| 1.89  | 0.059|
| GDP per Capita         | 0.32 | 0.07 | 4.50  | < 0.001|
| % Urban                | -0.74| 0.28 | -2.67 | 0.009|
| % Cultivated Land      | 0.16 | 0.14 | 1.16  | 0.249|
| % Rice                 | 0.12 | 0.05 | 2.55  | 0.013|
| % Herding Cultures     | 0.01 | 0.09 | 0.16  | 0.876|

Note: Analyses are HLMs with individuals nested in survey rounds nested in provinces. GDP is 2008 log RMB. Urbanization is the percent of urban residents per province. Herding cultures is the square root percent of the provincial population from traditionally herding cultures. The rice-wheat border analysis tests the percent rice among 10 neighboring provinces along China’s rice-wheat border.
RICE FARMING PREDICTS TIGHT NORMS

**Rice Farming Is Key, Not Farming in General**

One reasonable doubt is whether tight norms are specific to rice farming or farming in general. We pulled apart rice farming from farming in general by analyzing the percentage of cultivated land in different provinces (Table 1). Rice continued to predict tighter norms after taking into account farming in general. Thus, rice seems to have effects apart from farming in general.

**Rice Effect Is Separate from Population Density**

Researchers have theorized that societies develop tighter norms in response to population pressure (1). The idea is that tight social norms help societies deal with the dangers of crowding, such as disease and poor sanitation. There is some evidence for this. Around the world, nations with denser populations have tighter social norms (1), although this is not true among US states (3).

In China, densely populated provinces have tighter norms $r(29) = .54, P = 0.002$. But this correlation should be treated with caution because population density is highly correlated with urbanization ($r[29] = .71, P < 0.001$) and GDP in China ($r[29] = .68, P < .001$). When we pitted all three factors against each other in a single model, population density was no longer significant ($P = 0.698$), while GDP and urbanization remained highly significant (SI Appendix Table S5). Even pitting just GDP and population density against each other left population density non-significant. Thus, population density was not a robust predictor of norms in China.

Another possibility is that historical population density has a stronger influence on culture. Across nations, historical population density is a stronger predictor of norms than modern population density, perhaps because it more precisely reflected societies' long-run history (1). We tested this possibility in China using population density estimates from the 1700s for 22 provinces (SI Appendix Table S1).
RICE FARMING PREDICTS TIGHT NORMS

However, results were similar to modern density (SI Appendix Table S5). Historical density was correlated with tight norms, but this relationship disappeared after controlling for GDP.

We also ran analyses to explore whether population density might operate as a mechanism between rice and social norms. This could make sense with the fact that rice was far more productive per hectare than wheat and so could support denser populations (7). However, rice is only modestly correlated with population density in China $r(29) = .36, p = 0.045$.

Instead, population density is far more closely related to the density of farming in general $r(29) = .72, p < 0.001$. Shandong province in northern China is a good example. Shandong is a wheat province, yet it is one of China's densest farming areas, with 42% of land devoted to farming. In contrast, Guangdong and Fujian are rice provinces but with only about 10% of land devoted to farming.

The fact that rice and population density are separable can explain why rice remained significant after controlling for population density, both modern and historical (SI Appendix Table S5). Thus, rice-wheat differences seem to be operating outside of population density. However, we caution that provinces are coarse units of analysis to try to pull apart these variables. If future studies can gather county-level tightness data, they will have better granularity to test these factors.

Herding

Another plausible historical factor that could have influenced norm strength across China is herding. Herding cultures tend to be more individualistic than farming cultures (29, 30), and individualistic cultures tend to have looser norms (1). In line with this idea, a recent worldwide study found that herding cultures tend to have
looser, more flexible social relationships (23). However, herding areas in China did not have looser norms (Table 1).

**Environmental Threats**

One potential explanation for why herding areas did not have looser norms is that China's herding areas also experienced more historical warfare (Table 2). This is important because norms tend to be tighter in places that have experienced war and other types of environmental threats (1, 2). We tested this theory using historical data on disease prevalence, the frequency of war, and mass uprisings across China (Table 2, SI Appendix Table S4). Based on a simple correlation, regions that experienced more warfare had marginally tighter norms $r(29) = 0.36, P = 0.050$. However, warfare was more common in wealthier provinces, and warfare became non-significant after controlling for GDP (Table 2).

Rice continued to predict norm tightness after accounting for warfare, disease, and a series of alternative explanations and potential confound variables (SI Appendix Tables S3-S9; Table S1 describes all variables and theories tested). Rice was robust to distance from the coast (a proxy for trade and economic development), distance from Beijing (because norms tend to be tighter nearer to the central government, 2), ethnic homogeneity, and excluding outlying provinces like Tibet.

We also tested a wider set of indicators of modernization, such as service sector employment, private enterprise, and education (SI Appendix Tables S6-S8). In each case, we tested both modern and historical indicators. In line with the idea that there is a lag between economic development and cultural change (22), we found that historical GDP predicted norms better than the modern GDP statistics used in the original study (SI Appendix Table S8C).
## Rice Farming Predicts Tight Norms

### Table 2

*Rice Farming Is Robust to Historical Rebellion, Warfare, and Area Occupied by Japan in WWII*

| Variable                                | B/γ  | SE   | t    | P   |
|-----------------------------------------|------|------|------|-----|
| Historical Rebellion                    |      |      |      |     |
| Male                                    | 0.0004 | 0.0124 | .03  | 0.973 |
| Age                                     | 0.001 | 0.001 | 1.91 | 0.056 |
| GDP per Capita                          | 0.31  | 0.06  | 5.56 | < 0.001 |
| % Urban                                 | -0.64 | 0.24  | -2.64 | 0.010 |
| % Cultivated Land                       | 0.23  | 0.11  | 1.98 | 0.051 |
| % Rice                                  | 0.13  | 0.04  | 3.25 | 0.002 |
| Historical Rebellion                    | -0.04 | 0.02  | -1.84 | 0.069 |
| Historical Warfare                      |      |      |      |     |
| Male                                    | 0.001 | 0.012 | 0.05 | 0.960 |
| Age                                     | 0.001 | 0.001 | 1.90 | 0.058 |
| GDP per Capita                          | 0.30  | 0.07  | 4.52 | < 0.001 |
| % Urban                                 | -0.70 | 0.25  | -2.85 | 0.005 |
| % Cultivated Land                       | 0.18  | 0.12  | 1.54 | 0.127 |
| % Rice                                  | 0.12  | 0.04  | 2.92 | 0.005 |
| Historical Warfare                      | 0.004 | 0.005 | 0.76 | 0.448 |
| WWII Occupied Area                      |      |      |      |     |
| Male                                    | 0.001 | 0.013 | 0.09 | 0.925 |
| Age                                     | 0.001 | 0.001 | 1.19 | 0.236 |
| GDP per Capita                          | 0.33  | 0.06  | 5.58 | < 0.001 |
| % Urban                                 | -0.76 | 0.23  | -3.27 | 0.002 |
| % Cultivated Land                       | -0.06 | 0.14  | -0.43 | 0.670 |
| % Rice                                  | 0.10  | 0.04  | 2.43 | 0.017 |
| Area Occupied by Japan WWII             | 0.06  | 0.04  | 1.32 | 0.191 |

Note: Studies have found that areas with more history of warfare have tighter norms (1). Rebellion data is an index of the frequency mass rebellions during the Qing Dynasty (1644-1911, from 30).

"Historical Warfare" is the number of battles in wars with an external foe in the Qing Dynasty (30).

The proportion of provincial area occupied by Japan during WWII comes from Chua and colleagues (2). Occupied area significantly correlates with tightness \( r(28) = 0.59, P = 0.001 \) but becomes non-significant when controlling for GDP per capita. This is because rich coastal provinces were occupied to a greater extent \( r(28) = 0.62, P < 0.001 \). GDP data is log RMB from 2008. Urbanization is the percentage of urban residents per province in 2017.
RICE FARMING PREDICTS TIGHT NORMS

Differences Just as Large Along Rice-Wheat Border

One problem with using China as a natural test case is that rice is not randomly distributed. Instead, rice is highly correlated with temperature and latitude ($|r|s \geq 0.78$). To get around this problem, we compared people from 10 neighboring provinces along the rice-wheat border ($N = 3,835$). The border gives a cleaner test case of areas that differ starkly in rice, but much less in temperature and other variables. For example, Jiangsu province farms 60% rice, while neighboring Shandong farms just 2% rice.

Norms differed significantly along the rice-wheat border (Table 1). Differences were as large along the rice-wheat border ($r_{prov} = 0.43$) as for China as a whole ($r_{prov} = 0.33$). This result suggests that rice-wheat differences are independent from other factors that differ between northern and southern China as a whole, such as temperature and contact with herding cultures.

Environmental Suitability to Rice

If tight norms help people farm rice, it raises the question of reverse causality. Our theory is that rice causes tight norms, but the opposite could also be possible. Maybe people in China who already had tight norms chose to farm rice. One way to test whether people in some parts of China chose to farm rice is to ask where it's physically possible to grow rice. If all of China could grow rice, but only the regions that have tight norms actually grow rice, this would suggest that tight norms caused people to farm rice (reverse causality).

To test this idea, we mapped out where it's possible to grow rice using climate data from the United Nations Food and Agriculture Organization's Global Agro-Ecological Zones Database. This database estimates the environmental suitability for wetland rice based on temperature, slope, soil, and other variables from 1961 to 1990.
RICE FARMING PREDICTS TIGHT NORMS

Environmental suitability strongly predicted actual rice farming across China $\beta = 0.87$, $P < 0.001$. Environmental rice suitability also predicted tighter norms $\gamma = 0.001$, $P = 0.011$, $r_{prov} = 0.29$ (Table 1).

This suggests that the environment determined where people farm rice in China. Rice spread to the provinces where it was ecologically possible, probably because it was five times more productive per hectare than wheat (7). Although this analysis cannot entirely rule out reverse causality, the results suggest that reverse causality is not likely to be driving these cultural differences.

**Rice May Be Behind East-West Differences**

One intriguing possibility is that rice farming might help explain cultural differences beyond China. Theorists have proposed many different explanations for East-West differences, such as Confucianism and Eastern “despotism” (31, 32). We propose that East Asia’s history of rice farming has played at least some role in putting it on a different path from the wheat-farming West.
RICE FARMING PREDICTS TIGHT NORMS

Figure 2. Rice farming and norm tightness around the world. Norm data comes from a study by Gelfand and colleagues (1). Because Islamic countries tend to have stronger norms and several rice-farming cultures (such as Pakistan) have a high percentage of Muslims, the graph controls for percentage of Muslims. Rice is significant whether Islam is controlled for or not (Supplemental Section 20).
RICE FARMING PREDICTS TIGHT NORMS

Table 3
Societies with More Rice Farming and More Interdependent Subsistence Styles Have Tighter Norms

|                      | B     | SE    | t     | P    | B     | SE    | t     | P    | B     | SE    | t     | P    |
|----------------------|-------|-------|-------|------|-------|-------|-------|------|-------|-------|-------|------|
| Rice                 |       |       |       |      |       |       |       |      |       |       |       |      |
| % Rice Harvested Area| 5.69  | 1.75  | 3.24  | 0.003| 6.52  | 1.50  | 4.35  | <0.001| 5.50  | 1.48  | 3.71  | 0.001|
| GDP per Capita (2011 $10,000 PPP) | -0.11 | 0.07  | -0.40 | 0.693| 0.56  | 0.29  | 1.96  | 0.060|
| % Urban              |       |       |       |      |       |       |       |      |       |       |       |      |
|                     | -8.22 | 2.48  | -3.32 | 0.002| 0.07  | 0.02  | 3.23  | 0.003| 0.04  | 0.03  | 1.39  | 0.177|
| Historical and Ecological Threats |       |       |       |      |       |       |       |      |       |       |       |      |

| Subsistence Style     |       |       |       |      |       |       |       |      |       |       |       |      |
| Interdependent Subsistence Style Index | 4.30  | 1.56  | 2.76  | 0.010| 3.95  | 1.49  | 2.65  | 0.013| 3.56  | 1.46  | 2.44  | 0.021|
| GDP per Capita (2011 $10,000 PPP) | 0.04  | 0.29  | 0.13  | 0.898| 0.04  | 0.03  | 1.39  | 0.177|
| % Urban                |       |       |       |      |       |       |       |      |       |       |       |      |
|                       | -5.15 | 2.83  | -1.82 | 0.078| -5.87 | 4.16  | -1.41 | 0.170|
| Historical and Ecological Threats |       |       |       |      |       |       |       |      |       |       |       |      |

Note: Tightness-looseness values come from Gelfand and colleagues’ study of 32 nations (1). Rice is the percent of cereal production area harvested with rice. The subsistence index combines rice farming, wheat farming, and herding. Nations with more rice farming score higher on interdependence, while nations with more herding score lower on interdependence. Threat data is an index of seven threats, such as disease, warfare, and natural disasters. Gelfand and colleagues (1) identified these types of threats, and a later study on relational mobility combined them into a single index (19).
RICE FARMING PREDICTS TIGHT NORMS

We investigated this idea by testing whether rice farming predicts differences outside of China. To do this, we analyzed Gelfand’s tightness-looseness data from 32 nations around the world (1). We found that countries that devoted more cultivated land to paddy rice have tighter social norms $r(30) = 0.51, P = 0.003$ (Fig. 2). Rice farming continued to predict tight norms after taking into account modern economic development, historical development, urbanization, and environmental threats (Table 2, SI Appendix Table S10). Although rice is linked to interdependence (17), rice continued to predict norm tightness across China and around the world even after taking into account survey measures of individualism and collectivism (SI Appendix Table S12). This could suggest that rice influences norm tightness through means other than interdependence or that the survey measures are not precisely measuring the interdependence of rice farming.

Yet rice is just one subsistence style. Herding is another common traditional subsistence style around the world, and herding cultures tend to be more independent, with looser relationships (23, 29). To index herding, we used data on land devoted to herding around the world (SI Appendix 4). The data showed that herding cultures had less tight norms $r(30) = -0.45, P = 0.010$.

Finally, we combined rice farming, wheat farming, and herding into a broader index of subsistence styles (23). This index estimates the interdependence of different nations' subsistence styles. The index takes the proportion of cereal land devoted to wheat minus herding land (less interdependent) plus rice land (more interdependent;
RICE FARMING PREDICTS TIGHT NORMS

SI Appendix 4 describes the index in detail). The interdependent subsistence style index predicted norm tightness around the world $r(30) = 0.46, P = 0.009$ (Fig. 1). Subsistence styles continued to predict norms after taking into account GDP, urbanization, and environmental threats (Table 3, SI Appendix Table S11).

Rice Farming Linked to Thought Style

Next, we looked at data on one of the proposed consequences of tight norms. Tight cultures emphasize fitting in, which is good for coping with threats but bad for creativity (1, 3, 33, 34). In China, provinces with tighter norms scored lower on a measure of innovative thinking style and had fewer patents for inventions (2). If rice farming encourages tight norms, does it also predict differences in thought style and innovation?

Using Chua and colleagues’ thought style data, we found that rice-farming areas had lower innovative thinking style $\gamma = -0.11, P = 0.013$, $r_{prov} = -0.63$ (SI Appendix Fig. S1; Table 4). Next, we asked whether rice farming is linked to lower innovation because of norm tightness. A mediation analysis revealed that norm tightness explained a portion of the relationship between rice and lower innovative thought ($B = .043 [95\% CI = .013; .072], Z = 2.81, P = .005$; SI Appendix 1.1). In other words, rice-farming provinces have tighter norms, which are then linked to creativity (SI Appendix Fig. S4). However, norm tightness only explained a portion of the relationship between rice and innovation. This suggests there are pathways other than norm tightness at work.
Table 4

*Rice Farming Predicts Lower Innovative Thought Style*

|                | B/γ  | SE    | t     | P      |
|----------------|------|-------|-------|--------|
| Innovation     |      |       |       |        |
| Male           | 0.10 | 0.02  | 5.51  | < 0.001|
| Age            | -0.0003 | 0.0010 | -0.33 | 0.743  |
| GDP per Capita | 0.02 | 0.06  | 0.30  | 0.766  |
| % Urban        | 0.03 | 0.24  | 0.11  | 0.916  |
| % Cultivated Land | -0.02 | 0.11  | -0.20 | 0.844  |
| % Rice         | -0.11 | 0.04  | -2.69 | 0.013  |

Conformity

|                | B/γ  | SE    | t     | P      |
|----------------|------|-------|-------|--------|
| Male           | 0.003 | 0.016 | 0.18  | 0.860  |
| Age            | 0.001 | 0.001 | 1.56  | 0.118  |
| GDP per Capita | 0.10 | 0.05  | 1.88  | 0.072  |
| % Urban        | -0.32 | 0.21  | -1.48 | 0.152  |
| % Cultivated Land | -0.07 | 0.10  | -0.72 | 0.477  |
| % Rice         | -0.03 | 0.04  | -0.88 | 0.389  |

Efficiency

|                | B/γ  | SE    | t     | P      |
|----------------|------|-------|-------|--------|
| Male           | 0.02 | 0.02  | 0.98  | 0.328  |
| Age            | 0.007 | 0.001 | 7.43  | < 0.001|
| GDP per Capita | 0.09 | 0.06  | 1.47  | 0.154  |
| % Urban        | -0.13 | 0.26  | -0.50 | 0.620  |
| % Cultivated Land | 0.05 | 0.12  | 0.42  | 0.679  |
| % Rice         | -0.06 | 0.04  | -1.29 | 0.209  |

Note: Analyses are hierarchical linear models with individuals nested in survey rounds nested in provinces. GDP data is log RMB from 2008. Urbanization is the percentage of urban residents per province in 2017. Thought style data comes from Chua and colleagues (3), using Kirton’s adaption-innovation inventory (4).
RICE FARMING PREDICTS TIGHT NORMS

These results are consistent with the idea that rice farming encourages tight norms to deal with the high labor demands of rice but that this tightness comes at the cost of innovative thinking. The finding of lower innovative thought style is consistent with two earlier studies that found lower rates of invention patents in China’s rice areas (17, 35). In sum, separate datasets provide converging evidence linking rice to thought style and innovation.

Limitations

One important limitation with this analysis is that it compares provinces. Provinces are coarse units. With only 31 provinces, it is hard to pull different variables apart. For example, urbanization is highly correlated with GDP $r(29) = 0.89$, $P < 0.001$. Future studies can pull these variables apart more finely by collecting county-level data.

There are also several unanswered questions. For example, what elements of rice farming can be abstracted out to predict tight norms in other types of groups? Understanding this would help us predict beyond the three major subsistence styles we test here. Humans have developed many ways of eating and surviving besides rice, wheat, and herding.

There are some hints about other subsistence styles in prior research. For example, a team of researchers ran economic games in 15 small-scale societies around the world (36). Using the classic Ultimatum Game, they found the most generous offers among the Lamalera people of Indonesia. The Lamalera hunt whales. Taking
RICE FARMING PREDICTS TIGHT NORMS

down a whale is probably an impossible task for a single person. Instead, the Lamalera work together in teams to bring down their large prey, then split the harvest with other people back on shore. Data from more small-scale societies like these can give us a more detailed picture of which types of subsistence styles tend to create tight norms.

**Conclusion**

The earlier study found the paradoxical result that Chinese cities have tighter norms than rural areas (2). This contradicts data from the US, where cities have looser norms (3). This is also surprising because cities are hubs of creativity (26) and individualism (27), which are both more common where norms are loose (1, 2).

Maybe cities work differently in China. A commentary on the earlier findings offered one plausible explanation (28). Cities in China are dense with cameras and monitoring, which could make people feel more pressure to follow the rules. Yet when we compared places that were similarly wealthy, the more urbanized areas tended to have *looser* norms. Thus, the data supports the idea that cities are generally loose, rather than a China-specific pattern.

The new analysis also revealed evidence for a lag between economic change and cultural change. Studies of cultural differences often control for recent GDP statistics—even in studies that test for effects of historical factors. Yet there is evidence of a lag time between economic development and cultural change (22, 23). In China, GDP data from a decade before the survey predicted more variation in norm
tightness than current GDP data (SI Appendix Table S8C). To us, these findings suggest that testing historical indicators should become an expected standard in cultural research.

The Causes of Norm Tightness. This study advances our understanding of cultural differences by testing potential causes of those differences (1–3). This can be difficult when comparing different nations. If we compare, say, the US and China, factors like language, religion, and government are mixed together with factors like rice and wheat farming. The data here is particularly valuable because it leverages China as a natural test case. Comparing within China allows us to compare areas that share factors like language and national government, yet differ in rice and wheat.

Another way that this study (and other recent studies) on norm tightness have helped advance the field of cultural psychology is by pushing beyond individualism and collectivism. Individualism and collectivism are large, sometimes fuzzy concepts. Cultural psychologists have called for moving beyond collectivism to more precise traits (18). These studies on norm tightness are among a handful of studies in recent years that have pushed beyond collectivism (such as 1, 23).

Real-World Consequences. These results have real-world implications for Chinese society. Studies have linked norm tightness to important real-world outcomes (28). Tightness seems to bring some benefits. For one, tight norms seem to be useful for social coordination. People in societies with tight norms prioritize social order, self-regulate more, and abuse drugs less (28).
RICE FARMING PREDICTS TIGHT NORMS

But tight norms seem to hamper creativity (1, 3, 33, 34). Data from China's rice areas found lower innovative thought style (2) and fewer patents for new inventions (17, 35). Rice farm and the tight norms associated with it seem to be mismatched with the skillset needed for innovation. However, rice-farming southern China may excel at *incremental* innovations, which are more common in tight societies (28).

In contrast, the more freewheeling wheat-farming areas of northern China are more likely to be hubs of innovation. China's wheat areas are also probably easier places for newcomers to fit into, since loose societies are easier to acculturate to (37). These prior studies linking norm tightness to societal outcomes provide a road map of predictions that future studies can test across China.

**Will Rice-Wheat Differences Persist into the Future?** The analyses showed new evidence for differences that fall along the historical borders of rice and wheat farming—a factor that was overlooked in earlier analyses (2). Overlooking the effect of historical subsistence styles is easy to do because they are no longer a part of most people's everyday lives in China. For generations, most people in China worked in agriculture; only in 2003 did that number fall below 50% (38).

As more and more people enter apartments blocks and office jobs, the effects of China's thousands of years of rice farming will become easier and easier to overlook. This is gives researchers a unique opportunity. As it races to modernize, China gives researchers the chance to test in real time how culture changes.
RICE FARMING PREDICTS TIGHT NORMS

Yet the data here adds to the evidence that rice culture is living on in modern China (19, 23), even among college students in big cities (17), and even among customers in Starbucks (39). Old patterns of rice farming are living on, at least for now. How our ancestors put food on the table has left a legacy on how we order society—not just in China, but around the world.

Methods

We analyzed norm tightness data from 11,662 participants using hierarchical linear models with respondents nested in provinces and in three survey waves (from 2). Analyses took into account characteristics of respondents (gender and age) and provinces (log GDP per capita and urbanization). Because the urbanization ratio from the original paper was skewed (2.69), we used percentages. Percentages were less skewed (0.68) and predicted tightness \((r = 0.56)\) slightly more strongly than ratios \((r = 0.52)\).

To measure historical rice farming, we used the percent of paddy fields per cultivated land, as in prior research (17). To represent historical farming, we used the earliest provincial data we could find, from the 1996 China Statistical Yearbook. This data correlates highly with 1918 data available for a subset of 22 provinces \(r(22) = 0.95, P < 0.001\). Thus, the 1996 data seems to adequately represent historical patterns of rice farming.
We use data on paddy rice rather than rice output. This is because rice output also includes dryland rice. Dryland rice is less productive and grows without the irrigation systems that force farmers to coordinate their behavior (7).

**Data Availability.** Data and analysis scripts are publicly available in the Open Science Framework.

**References**

1. M. J. Gelfand, et al., Differences between tight and loose cultures: A 33-nation study. *Science* **332**, 1100–1104 (2011).

2. R. Y. Chua, K. G. Huang, M. Jin, Mapping cultural tightness and its links to innovation, urbanization, and happiness across 31 provinces in China. *Proc. Natl. Acad. Sci.*, 201815723 (2019).

3. J. R. Harrington, M. J. Gelfand, Tightness–looseness across the 50 united states. *Proc. Natl. Acad. Sci.* **111**, 7990–7995 (2014).

4. P. Roos, M. Gelfand, D. Nau, J. Lun, Societal threat and cultural variation in the strength of social norms: An evolutionary basis. *Organ. Behav. Hum. Decis. Process.* **129**, 14–23 (2015).

5. T. Talhelm, Emerging evidence of cultural differences linked to rice versus wheat agriculture. *Curr. Opin. Psychol.* **32**, 81–88 (2020).

6. J. L. Buck, *Land utilization in China* (Chicago University Press, 1935) (July 31, 2017).

7. T. Talhelm, S. Oishi, “How rice farming shaped culture in Southern China” in *Socioeconomic Environment and Human Psychology*, A. K. Uskul, S. Oishi, Eds. (Oxford University Press, 2018), pp. 53–76.

8. F. Bray, *The rice economies: Technology and development in Asian societies*. (Blackwell, 1986) (July 31, 2017).

9. X. Fei, *Chinese village close-up* (New World Press, 1983).

10. T. Suehara, Labor exchange systems in Japan and DR Congo: Similarities and differences. *Afr. Stud. Q.* **9**, 55–65 (2006).
RICE FARMING PREDICTS TIGHT NORMS

11. X. Fei, Earthbound China: A study of rural economy in Yunnan (University of Chicago Press, 1945).

12. S. Oishi, M. Koo, N. Lim, E. M. Suh, When Gratitude Evokes Indebtedness. Appl. Psychol. Health Well-Being, 286–303 (2019).

13. G. S. Khush, Origin, dispersal, cultivation and variation of rice. Plant Mol. Biol. 35, 25–34 (1997).

14. M. Elvin, The retreat of the elephants: An environmental history of China (Yale University Press, 2008).

15. J. Park, S. Kitayama, Interdependent selves show face-induced facilitation of error processing: cultural neuroscience of self-threat. Soc. Cogn. Affect. Neurosci. 9, 201–208 (2012).

16. T. Yamagishi, N. Suzuki, “An institutional approach to culture” in Evolution, Culture, and the Human Mind, M. Schaller, A. Norenzayan, S. J. Heine, T. Yamagishi, T. Kameda, Eds. (Taylor & Francis Group, 2009), pp. 185–203.

17. T. Talhelm, et al., Large-scale psychological differences within China explained by rice versus wheat agriculture. Science 344, 603–608 (2014).

18. V. L. Vignoles, et al., Beyond the ‘east–west’ dichotomy: Global variation in cultural models of selfhood. J. Exp. Psychol. Gen. 145, 966–1000 (2016).

19. S. Liu, M. W. Morris, T. Talhelm, Q. Yang, Ingroup vigilance in collectivistic culture. Proc. Natl. Acad. Sci. 116, 14538–14546 (2019).

20. R. I. Swaab, M. Schaerer, E. M. Anicich, R. Ronay, A. D. Galinsky, The too-much-talent effect: Team interdependence determines when more talent is too much or not enough. Psychol. Sci. 25, 1581–1591 (2014).

21. N. Halevy, E. Y. Chou, A. D. Galinsky, J. K. Murnighan, When hierarchy wins: Evidence from the national basketball association. Soc. Psychol. Personal. Sci. 3, 398–406 (2012).

22. I. Grossmann, M. E. Varnum, Social structure, infectious diseases, disasters, secularism, and cultural change in America. Psychol. Sci. 26, 311–324 (2015).

23. R. Thomson, et al., Relational mobility predicts social behaviors in 39 countries and is tied to historical farming and threat. Proc. Natl. Acad. Sci. 115, 7521–7526 (2018).
24. D. Stockemer, A. Sundström, Modernization theory: How to measure and operationalize it when gauging variation in women’s representation? *Soc. Indic. Res.* **125**, 695–712 (2016).

25. R. Inglehart, W. E. Baker, Modernization, cultural change, and the persistence of traditional values. *Am. Sociol. Rev.* **65**, 19–51 (2000).

26. R. Martin, R. Florida, M. Pogue, C. Mellander, Creativity, clusters and the competitive advantage of cities. *Compet. Rev.* **25**, 482–496 (2015).

27. T. Yamagishi, H. Hashimoto, Y. Li, J. Schug, Stadtluft macht frei (City air brings freedom). *J. Cross-Cult. Psychol.* **43**, 38–45 (2012).

28. M. J. Gelfand, Universal and culture-specific patterns of tightness-looseness across the 31 Chinese provinces. *Proc. Natl. Acad. Sci.* **116**, 6522–6524 (2019).

29. A. K. Uskul, S. Kitayama, R. E. Nisbett, Ecocultural basis of cognition: Farmers and fishermen are more holistic than herders. *Proc. Natl. Acad. Sci.* **105**, 8552–8556 (2008).

30. A. K. Uskul, H. Over, Responses to social exclusion in cultural context: Evidence from farming and herding communities. *J. Pers. Soc. Psychol.* **106**, 752–771 (2014).

31. M. Weber, *The Protestant ethic and the spirit of capitalism* (Routledge, 2013).

32. K. A. Wittfogel, Oriental despotism: A comparative study of total power. *Sci. Soc.* **23**, 58–65 (1959).

33. J. C. Jackson, M. Gelfand, S. De, A. Fox, The loosening of American culture over 200 years is associated with a creativity–order trade-off. *Nat. Hum. Behav.* **3**, 244–250 (2019).

34. R. Y. Chua, Y. Roth, J.-F. Lemoine, The impact of culture on creativity: How cultural tightness and cultural distance affect global innovation crowdsourcing work. *Adm. Sci. Q.* **60**, 189–227 (2015).

35. J. Zhu, J. B. Ang, P. G. Fredriksson, The agricultural roots of Chinese innovation performance. *Eur. Econ. Rev.* **118**, 126–147 (2019).

36. J. Henrich, *et al.*, In search of homo economicus: Behavioral experiments in 15 small-scale societies. *Am. Econ. Rev.* **91**, 73–78 (2001).

37. N. Geeraert, R. Li, C. Ward, M. J. Gelfand, K. A. Demes, A tight spot: How personality moderates the impact of social norms on sojourner adaptation. *Psychol. Sci.* **30**, 333–342 (2019).
RICE FARMING PREDICTS TIGHT NORMS

38. World Bank, “Employment in agriculture” (2018) (February 26, 2019).

39. T. Talhelm, X. Zhang, S. Oishi, Moving chairs in Starbucks: Observational studies find rice-wheat cultural differences. Sci. Adv. 4, eaap8469 (2018).

Acknowledgments: We thank Roy Chua, Kenneth Huang, and Mengzi Jin for making their original data openly accessible and for helpful feedback on this paper. We thank Liuqing Wei for help collecting data, Yuxin Wang for expert editing, Michele Gelfand for providing threat score data, Yuhua Wang for regional data on warfare and other indicators, and Jiong Zhu for help with spatial data. Thanks to Graham Noblit, Jesse Kluver, and Masaki Yuki for helpful feedback on early drafts.
Figure SI. Rice provinces scored lower on Chua and colleagues’ measure of innovative thinking style (Table 4).
RICE FARMING PREDICTS TIGHT NORMS

Figure S2. Provinces with more holistic thought tend to score lower on innovative thinking style, suggesting that the two measures tap into similar constructs. Each dot represents a province. Holistic thought is the percentage of relational pairings on the triad categorization task from Talhelm and colleagues (1). Innovative thinking style comes from a measure in the tightness-looseness study in China by Chua and colleagues (2). Rice significantly predicted innovative thinking style, but not the other two thought style sub-dimensions measured by Chua and colleagues (Table 4). Two outlying provinces with small samples that scored under 60% on holistic thought are not shown in the graph, but they are included in the analysis.
Figure S3. Paddy rice farming is centered in central China around the Yangtze River and further south. In the north, dryland crops like wheat, corn, and millet are common. Data comes from the 1996 China Statistical Yearbook.
Mediation analysis found that norm tightness partially mediated the link between rice and innovative thought. Values are regression coefficients [with bootstrapped 95\% confidence intervals]. This mediation uses province-level cultural tightness. Figure S5 presents similar results using individual-level cultural tightness.
Mediation analysis found that norm tightness partially mediated the link between rice and innovative thought. Values are regression coefficients [with bootstrapped 95% confidence intervals]. This mediation uses individual-level cultural tightness. Figure S4 finds similar results using province-level cultural tightness.
### Table S1: Part One  
**Variables Tested, Sources, and Rationale**

| Variable              | Measure                                           | Source                                                                 | Rationale                                                                                                                                 |
|-----------------------|---------------------------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| % Rice                | Paddy fields area/total cultivated area           | *China Statistical Yearbook, 1996*                                     | Paddy rice required more work and coordination to build and operate irrigation systems.                                                     |
| Modern GDP            | GDP per capita in 2008, 2012, 2015                | *China Statistical Yearbook, 2009, 2013, 2016                           | More developed provinces tend to have tighter norms (2).                                                                                   |
| Historical GDP        | Log GDP Per Capita in 1995                        | *China Statistical Yearbook, 1996*                                     | Studies have found a lag between economic growth and cultural change (3).                                                                |
| % Urban               | Urban residents/total population, 2000, 2016      | *China Population and Employment Statistical Yearbook, 2001, 2017       | Urbanized Chinese provinces tend to have tighter norms (2). We also test historical urbanization to test for a lagged effect.                |
| % Cultivated Land     | Hectares of cultivated land/total province land  | *China Statistical Yearbook, 1996*                                     | This measures the density of farming in general, pulling apart general farming and rice farming in particular.                              |
| Environmental Rice Suitability | Environmental suitability for high-input rainfed rice | UN Global Agro-Ecological Zones Database                              | Environmental suitability for rice (regardless of whether people actually farm rice there) helps address reverse-causality—the possibility that areas that were collectivistic to begin with chose to farm rice. |
| % Herding Cultures    | People from herding ethnicities/total pop.       | *China Pop. Stat. Yearbook, 2002*                                     | Research has found that herding cultures tend to be more individualistic than nearby farming cultures (4).                                  |
| Percent Han           | People of Han ethnicity/province population      | *China Population Statistical Yearbook, 2002*                          | The percent Han could be interpreted as a measure of ethnic homogeneity (lack of diversity) or as a proxy for Confucian heritage.           |
| Distance from Beijing | Log distance of prov. capital city to Beijing (1,000 km) | Google Maps                                                           | Central government control may be stronger near the capital. Provinces nearer the central government have tighter norms on average (2). |
| Population Density    | Population/province area                         | *China Stat. Yb. 1996*                                                | Nations with higher population density tend to have tighter norms (5).                                                                  |
| Historical Pop. Dens. | Population/province area                         | Shepherd, 1993                                                        | Historical population density predicts norms better than modern density (5).                                                             |
RICE FARMING PREDICTS TIGHT NORMS

Table S1: Part Two
Variables Tested, Sources, and Rationale

| Variable                        | Measure                                                                 | Source                                                                 | Rationale                                                                                                                                                                                                 |
|---------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Distance to Coast               | Distance of prov. capital to nearest coast (100 km). Coast prov. = 0.  | Marine Regions Database (from 6)                                       | Distance from the coast can be a proxy for development (modern and historical). Coastal provinces also had more access to sea transport and potentially more diverse ideas and cultures.                                    |
| Average Temperature             | Average (average high, low in January and July)                         | Zuzu Che Weather Records                                               | Some researchers have argued that hotter areas are more collectivistic (7). Temperature is correlated with disease prevalence (7).                                                                         |
| Latitude                        | Average of northernmost and southernmost province latitude              | Google Maps                                                             | In China, rice is highly correlated with latitude. Latitude is a proxy for other environmental factors such as temperature and disease. Testing latitude checks the robustness of rice against latitude.            |
| Pathogen Prevalence             | Average morbidity rates for human-transmitted diseases                 | China Statistical Yearbook of Health, 2001                              | Pathogen prevalence theory argues that environments with higher rates of communicable disease tend to be more collectivistic (8).                                                                         |
| % College Graduates             | College graduates per school-age population, 1990, 2015                 | China Statistical Yearbook, 1991, 2016                                  | Researchers have argued that education is an important vehicle of modernization (9). We test modern and historical statistics.                                                                         |
| % Service Industry              | People employed in service jobs/employed people, 2010, 1995            | China Statistical Yearbook, 2011, 1996                                  | Some researchers have argued that service sector development is a better indicator of modernization than GDP (10). We test historical statistics because there is evidence for a lag between economic development and cultural change (3). |
| % Private Industry              | People employed in priv. industry per employed people, 2010, 1995      | China Statistical Yearbook, 2011, 1996                                  | In China, the shift from the state-controlled economy to the private sector may be an indicator of modernization beyond GDP. We test historical statistics because there is evidence for a lag between economic development and cultural change (3). |
| Internet Penetration            | Internet users/total province population                               | China Internet Development Report, 2008                                | Researchers have found some evidence that GDP statistics in China are sometimes manipulated (11). Internet installation rates are less politically sensitive and thus present an alternative indicator of modernization. |
| Qing Rebellion, Warfare         | Frequency of rebellions, warfare in Qing Dynasty, 2018                 | Dincecco & Wang, 2018                                                   | Prior research has found tighter norms in places with a history of warfare (5). Beyond external warfare, rebellions killed millions in the Qing Dynasty (1644-1911).                                    |
| Area Occupied by Japan in WWII  | Proportion of provincial area occupied by Japan, 2018                  | Chua et al., 2019                                                       | Prior research has found tighter norms in places with a history of warfare (5), including this measure in China specifically (2).                                                                     |
### Table S1: Part Three

| Variable                                | Measure                                                                 | Source                                      | Rationale                                                                                                                                                                                                 |
|-----------------------------------------|-------------------------------------------------------------------------|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| % Rice Harvested Area                   | Irrig. wetland rice harv. area/cereal cultivation land in 2000          | UNFAO & World Bank                          | Paddy rice required more work and coordination to build and operate irrigation systems.                                                                                                                      |
| Interdependent Subsistence Style Index  | (Wheat harv. area/cereal cult. area) + (rice harv. area/cereal cult. area) – prop. pasture land. | Thomson et al., 2018                        | This index combines three subsistence styles linked to cultural differences: rice more interdependent than wheat (1), and herding which is more independent than farming in general (4). |
| GDP per Capita                          | GDP per capita, 2011 ($10,000, PPP)                                      | World Bank                                  | Economically developed areas have tighter norms in China (2), although this seems to not hold internationally (5).                                                                                         |
| Historical GDP                          | GDP per capita in 1950 ($1,000)                                         | Maddison                                    | Studies have found a lag between economic growth and cultural change (3).                                                                                                                                   |
| Historical and Ecological Threats       | Index of 7 threats, such as warfare, disease, and natural disaster      | Gelfand et al., 2011; Thomson et al., 2018  | Societies with histories of more ecological threats tend to have tighter norms (5). Threat index includes (i) history of territorial threats, (ii) demanding geoclimate, (iii) historical pathogen prevalence, (iv) tuberculosis incidence, (v) natural disaster vulnerability, (vi) population density in 1500, (vii) daily fat supply (reversed). |
| UN Human Development Index              | Life expectancy, education, and income per capita, 2010                | UN Human Development Report                 | The HDI is a broader index of development than GDP alone.                                                                                                                                                  |
| % Urban                                 | Percent of people living in urban areas, 2018                           | CIA World Factbook                          | Studies have linked urbanization to differences in norm tightness (2, 12).                                                                                                                              |
Table S2
Separating Urbanization and Wealth

|                          | $\beta$   | SE     | t      | P      |
|--------------------------|-----------|--------|--------|--------|
| Male                     | 0.001     | 0.012  | 0.10   | 0.924  |
| Age                      | 0.001     | 0.001  | 1.93   | 0.054  |
| % Cultivated Land        | 0.11      | 0.11   | 0.97   | 0.336  |
| % Rice                   | 0.07      | 0.04   | 1.75   | 0.085  |
| Log GDP per Capita       | 0.16      | 0.03   | 5.56   | < 0.001|
| Male                     | 0.0003    | 0.0124 | 0.02   | 0.984  |
| Age                      | 0.001     | 0.001  | 2.00   | 0.046  |
| % Cultivated Land        | 0.25      | 0.12   | 2.02   | 0.047  |
| % Rice                   | 0.05      | 0.04   | 1.23   | 0.222  |
| % Urban                  | 0.40      | 0.13   | 2.99   | 0.004  |

Note: Table 1 has urbanization and wealth in the simultaneous regressions. Results here show that each on its own predicts tighter norms. But when put together (Table 1), urbanization predicts looser norms, in line with earlier results from the US (12). Analyses are hierarchical linear models with individuals nested in survey rounds nested in provinces. GDP data is log RMB from 2008. Urbanization is the percentage of urban residents per province in 2017.
Table S3A

Rice Farming Predicts Tighter Norms Controlling for Distance from Beijing and Distance to Coast

|                           | $B/\gamma$ | SE  | $t$   | $P$   |
|---------------------------|------------|-----|-------|-------|
| Male                      | 0.001      | 0.012 | 0.07 | 0.947 |
| Age                       | 0.001      | 0.001 | 1.89 | 0.058 |
| GDP per Capita            | 0.33       | 0.06 | 5.76  | < 0.001 |
| % Urban                   | -0.86      | 0.26 | -3.26 | 0.002 |
| % Cultivated Land         | 0.14       | 0.11 | 1.31  | 0.193 |
| % Rice                    | 0.14       | 0.05 | 2.77  | 0.007 |
| Distance from Beijing     | -0.01      | 0.01 | -0.80 | 0.429 |
| Male                      | 0.001      | 0.012 | 0.06 | 0.955 |
| Age                       | 0.001      | 0.001 | 1.90 | 0.058 |
| GDP per Capita            | 0.32       | 0.06 | 5.49  | < 0.001 |
| % Urban                   | -0.76      | 0.24 | -3.20 | 0.002 |
| % Cultivated Land         | 0.13       | 0.12 | 1.06  | 0.293 |
| % Rice                    | 0.11       | 0.05 | 2.41  | 0.018 |
| Distance to Coast         | -0.001     | 0.003 | -0.30 | 0.767 |

Note: Distance from Beijing is in 1,000 km, log transformed. Distance to Coast is in 100 km from the provincial capital, but zero for coastal provinces. Analyses are hierarchical linear models with individuals nested in survey rounds nested in provinces. GDP data is log RMB from 2008. Urbanization is the percentage of urban residents per province in 2017.
RICE FARMING PREDICTS TIGHT NORMS

Table S3B

*Temperature and Latitude Do Not Predict Tight Norms Within Rice and Wheat Regions, Where Rice and Temperature Are De-Confounded*

| Rice Region | B/γ  | SE   | t    | P    |
|-------------|------|------|------|------|
| Male        | 0.01 | 0.02 | 0.67 | 0.505|
| Age         | 0.002| 0.001| 1.65 | 0.099|
| GDP per Capita | 0.35 | 0.13 | 2.69 | 0.043|
| % Urban     | -0.63| 0.69 | -0.91| 0.407|
| % Cultivated Land | -0.20 | 0.36 | -0.56| 0.602|
| Yearly Average Temperature (C) | -0.01 | 0.01 | -0.42| 0.677|
| Male        | 0.01 | 0.02 | 0.67 | 0.505|
| Age         | 0.002| 0.001| 1.65 | 0.099|
| GDP per Capita | 0.36 | 0.13 | 2.77 | 0.040|
| % Urban     | -0.67| 0.68 | -0.99| 0.369|
| % Cultivated Land | -0.20 | 0.37 | -0.54| 0.614|
| Latitude    | 0.003| 0.008| 0.38 | 0.717|

| Wheat Region | B/γ  | SE   | t    | P    |
|--------------|------|------|------|------|
| Male         | -0.01| 0.02 | -0.45| 0.652|
| Age          | 0.003| 0.001| 2.80 | 0.005|
| GDP per Capita | 0.26 | 0.08 | 3.22 | 0.007|
| % Urban      | -0.64| 0.30 | -2.14| 0.053|
| % Cultivated Land | 0.31 | 0.15 | 2.05 | 0.063|
| Yearly Average Temperature (C) | -0.006| 0.004| -1.36| 0.199|
| Male         | -0.01| 0.02 | -0.46| 0.648|
| Age          | 0.003| 0.001| 2.81 | 0.005|
| GDP per Capita | 0.28 | 0.09 | 3.03 | 0.010|
| % Urban      | -0.70| 0.31 | -2.23| 0.046|
| % Cultivated Land | 0.25 | 0.16 | 1.61 | 0.133|
| Latitude     | 0.001| 0.004| 0.25 | 0.806|

Note: Analyses on the left are within China’s rice region (percent cultivated land ≥ 50% paddy rice); analyses on the right are within China’s wheat region (< 50% rice). In China as a whole, rice is strongly correlated with temperature and latitude. But within the rice region and within the wheat region, there is very little variance in rice, but still large variation in temperature and latitude. Shaded rows correlate in the opposite direction from what theory would predict. GDP data is log RMB from 2008. Urbanization is the percentage of urban residents per province in 2017.
RICE FARMING PREDICTS TIGHT NORMS

Table S4
Rice Farming Robust to Ethnic Han Makeup and Pathogen Prevalence

|                   | $\beta/\gamma$ | $\text{SE}$ | $t$  | $P$  |
|-------------------|----------------|-------------|------|------|
| Male              | 0.001          | 0.012       | 0.05 | 0.960|
| Age               | 0.001          | 0.001       | 1.90 | 0.058|
| GDP per Capita    | 0.34           | 0.06        | 5.62 | < 0.001|
| % Urban           | -0.85          | 0.26        | -3.27| 0.002|
| % Cultivated Land| 0.09           | 0.13        | 0.71 | 0.478|
| % Rice            | 0.11           | 0.04        | 2.71 | 0.008|
| Percent Han       | 0.06           | 0.08        | 0.76 | 0.448|
| Male              | 0.001          | 0.012       | 0.06 | 0.954|
| Age               | 0.001          | 0.001       | 1.90 | 0.058|
| GDP per Capita    | 0.32           | 0.06        | 5.68 | < 0.001|
| % Urban           | -0.76          | 0.24        | -3.24| 0.002|
| % Cultivated Land| 0.14           | 0.12        | 1.17 | 0.244|
| % Rice            | 0.11           | 0.04        | 2.86 | 0.005|
| Pathogen Prevalence| -0.0004       | 0.0036      | -0.10| 0.920|

Note: GDP data is log RMB from 2008. Urbanization is the percentage of urban residents per province in 2017. Percent Han comes from the 2000 Census. Pathogen prevalence is a measure of morbidity from human-transmitted diseases per province (more details are in Supplemental Section 13).
RICE FARMING PREDICTS TIGHT NORMS

Table S5

Population Density and Historical Urbanization

|                     | $B/\gamma$ | SE  | t    | P    |
|---------------------|------------|-----|------|------|
| Male                | 0.001      | 0.012 | 0.05 | 0.958 |
| Age                 | 0.001      | 0.001 | 1.90 | 0.058 |
| GDP per Capita      | 0.32       | 0.06  | 5.68 | < 0.001 |
| % Cultivated Land   | 0.18       | 0.14  | 1.30 | 0.198 |
| % Rice              | 0.12       | 0.04  | 2.77 | 0.007 |
| % Urban 2017        | -0.75      | 0.24  | -3.15| 0.002 |
| Population Density  | -0.21      | 0.54  | -0.39| 0.698 |

Rice Robust to Population Historical Density

|                     | $B/\gamma$ | SE  | t    | P    |
|---------------------|------------|-----|------|------|
| Male                | -0.003     | 0.014 | -0.25| 0.803 |
| Age                 | 0.002      | 0.001 | 2.06 | 0.040 |
| GDP per Capita      | 0.38       | 0.08  | 5.26 | < 0.001 |
| % Cultivated Land   | 0.02       | 0.18  | 0.11 | 0.916 |
| % Rice              | 0.11       | 0.05  | 2.22 | 0.031 |
| % Urban 2017        | -0.93      | 0.29  | -3.19| 0.002 |
| Population Density  | -1.31      | 3.31  | -0.39| 0.695 |

Population Density in 1700s

|                     | $B/\gamma$ | SE  | t    | P    |
|---------------------|------------|-----|------|------|
| Male                | 0.001      | 0.012 | 0.10 | 0.920 |
| Age                 | 0.001      | 0.001 | 1.87 | 0.061 |
| GDP per Capita      | 0.17       | 0.08  | 6.83 | < 0.001 |
| Population Density  | 0.25       | 0.41  | 0.61 | 0.545 |

Note: Population density is a candidate for a mechanism between rice and norm tightness, but results find rice remains significant after taking into account both current and historical density. Rice becomes marginally significant using urbanization statistics from 2001, perhaps because pre-modern urbanization is a less effective predictor than modern urbanization. Population density 1996 is calculated as 100,000,000 people per km² from the 1996 Statistical Yearbook. Historical population density is calculated as 10,000 people per km² from Statecraft and Political Economy on the Taiwan Frontier, 1600-1800. GDP data is log RMB from 2008. Urbanization is the percentage of urban residents per province in 2001 (to represent pre-modern urbanization and 2017 to represent modern urbanization.
Table S6

*Rice Farming is Robust to Individual Education and Regional Education Differences*

| Variable            | B/γ   | SE   | t     | P    | B/γ   | SE   | t     | P    | B/γ   | SE   | t     | P    |
|---------------------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|
| Male                | 0.004 | 0.015| 0.25  | 0.802| 0.001 | 0.012| 0.07  | 0.944| 0.001 | 0.012| 0.07  | 0.943|
| Age                 | 0.001 | 0.001| 1.31  | 0.190| 0.001 | 0.001| 1.89  | 0.059| 0.001 | 0.001| 1.89  | 0.059|
| GDP per Capita      | 0.30  | 0.07 | 4.19  | < 0.001 | 0.32  | 0.06 | 5.74  | < 0.001 | 0.33  | 0.06 | 5.75  | < 0.001|
| % Urban             | -0.64 | 0.30 | -2.14 | 0.037| -0.91 | 0.30 | -2.99 | 0.004| -0.91 | 0.30 | -3.02 | 0.003|
| % Cultivated Land   | 0.20  | 0.14 | 1.44  | 0.155| 0.16  | 0.11 | 1.48  | 0.142| 0.16  | 0.11 | 1.48  | 0.139|
| % Rice              | 0.12  | 0.05 | 2.47  | 0.017| 0.13  | 0.05 | 2.89  | 0.005| 0.13  | 0.05 | 2.92  | 0.004|
| Education Variable  | 0.01  | 0.01 | 1.38  | 0.168| 0.002 | 0.003| 0.74  | 0.462| 0.01  | 0.01 | 0.78  | 0.437|

Respondent's Education  | Province % College Grads 2015 | Province % College Grads 1990

Note: Respondents’ education is coded from 1 to 5, with higher values representing more education (2). GDP data is log RMB from 2008. Urbanization is the percentage of urban residents per province in 2017.
### Table S7A

**Are Alternative Measures of Modernization Better Predictors of Tightness?**

|                      | \(B/\gamma\) | SE  | \(t\)  | \(P\)  |
|----------------------|---------------|-----|--------|--------|
| Male                 | 0.001         | 0.012 | 0.10  | 0.924  |
| Age                  | 0.001         | 0.001 | 1.87  | 0.061  |
| GDP per Capita 2008  | 0.18          | 0.02  | 7.40  | < 0.001|
| Male                 | -0.0002       | 0.0124 | -0.02 | 0.984  |
| Age                  | 0.001         | 0.001 | 2.02  | 0.043  |
| Log % Employed in Service Industry 2010 | 0.21 | 0.07 | 2.91 | 0.005 |
| Male                 | 0.001         | 0.012 | 0.07  | 0.942  |
| Age                  | 0.001         | 0.001 | 1.87  | 0.062  |
| GDP per Capita 2008  | 0.21          | 0.03  | 6.66  | < 0.001|
| Log % Employed in Service Industry 2010 | -0.10 | 0.07 | -1.34 | 0.183 |
| Male                 | 0.001         | 0.012 | 0.07  | 0.945  |
| Age                  | 0.001         | 0.001 | 1.89  | 0.059  |
| GDP per Capita 2008  | 0.33          | 0.06  | 5.75  | < 0.001|
| Log % Employed in Service Industry 2010 | 0.07 | 0.09 | 0.75 | 0.454 |
| % Urban              | -0.88         | 0.28  | -3.12 | 0.003  |
| % Cultivated Land    | 0.17          | 0.11  | 1.52  | 0.132  |
| % Rice               | 0.12          | 0.04  | 2.99  | 0.004  |

Note: GDP per capita from 2008 is log-transformed RMB. Some researchers have argued that service sector development is a better indicator of modernization than GDP.
### Table S7B

**Are Alternative Measures of Modernization Better Predictors of Tightness?**

|                          | $B/\gamma$ | SE  | $t$  | $P$   |
|--------------------------|------------|-----|------|-------|
| Male                     | 0.001      | 0.012 | 0.05 | 0.960 |
| Age                      | 0.001      | 0.001 | 1.94 | 0.052 |
| Log % Employed in Private Industry 2010 | 0.13       | 0.02  | 5.99 | < 0.001 |
| Male                     | 0.001      | 0.012 | 0.10 | 0.922 |
| Age                      | 0.001      | 0.001 | 1.87 | 0.062 |
| Log GDP per Capita 2008  | 0.17       | 0.05  | 3.61 | < 0.001 |
| Log % Employed in Private Industry 2010 | 0.01       | 0.04  | 0.26 | 0.799 |
| Male                     | 0.001      | 0.012 | 0.06 | 0.951 |
| Age                      | 0.001      | 0.001 | 1.99 | 0.047 |
| Internet Penetration     | 0.85       | 0.12  | 7.00 | < 0.001 |
| Male                     | 0.001      | 0.012 | 0.12 | 0.908 |
| Age                      | 0.001      | 0.001 | 1.90 | 0.057 |
| Log GDP per Capita 2008  | 0.12       | 0.05  | 2.39 | 0.019 |
| Internet Penetration     | 0.35       | 0.24  | 1.45 | 0.152 |
| Male                     | 0.001      | 0.012 | 0.08 | 0.939 |
| Age                      | 0.001      | 0.001 | 1.90 | 0.057 |
| Log GDP per Capita 2008  | 0.24       | 0.07  | 3.39 | 0.001 |
| Internet Penetration     | 0.54       | 0.26  | 2.04 | 0.044 |
| % Urban                  | -0.86      | 0.23  | -3.66| < 0.001 |
| % Cultivated Land        | 0.23       | 0.11  | 2.04 | 0.044 |
| % Rice                   | 0.09       | 0.04  | 2.09 | 0.039 |

Note: Internet penetration statistics come from 2007 and represent an alternative measure of development from GDP statistics, which some have questioned as manipulated. In China, the shift from the state-controlled economy to the private sector may also be an indicator of modernization beyond GDP. GDP per capita from 2008 is log-transformed RMB.
Table S8A

*Are Historical Measures of Modernization Better Predictors of Tight Norms?*

|                    | $B/\gamma$ | SE  | $t$  | $P$   |
|--------------------|------------|-----|------|-------|
| Male               | 0.001      | 0.012 | 0.10 | 0.924 |
| Age                | 0.001      | 0.001 | 1.87 | 0.061 |
| Log GDP per Capita 2008 | 0.18       | 0.02 | 7.40 | < 0.001 |
| Male               | 0.002      | 0.013 | 0.16 | 0.873 |
| Age                | 0.001      | 0.001 | 1.55 | 0.121 |
| % Employed in Service Industry 1995 | 0.010 | 0.002 | 4.74 | < 0.001 |
| Male               | 0.003      | 0.013 | 0.22 | 0.829 |
| Age                | 0.001      | 0.001 | 1.43 | 0.152 |
| Log GDP per Capita 2008 | 0.19       | 0.04 | 4.86 | < 0.001 |
| % Employed in Service Industry 1995 | -0.001 | 0.003 | -0.43 | 0.667 |
| Male               | 0.003      | 0.013 | 0.21 | 0.831 |
| Age                | 0.001      | 0.001 | 1.48 | 0.139 |
| Log GDP per Capita 2008 | 0.33       | 0.06 | 5.60 | < 0.001 |
| % Employed in Service Industry 1995 | 0.009 | 0.004 | 2.44 | 0.017 |
| % Urban            | -1.28      | 0.32 | -4.01 | < 0.001 |
| % Cultivated Land  | 0.25       | 0.11 | 2.17 | 0.033 |
| % Rice             | 0.14       | 0.04 | 3.53 | < 0.001 |

Note: GDP statistics are log transformed. Urbanization is the percentage of urban residents per province in 2017. Service sector and private employment are alternative measures of modernization. These statistics from the 1990s represent time-lagged, historical measures of modernization.
RICE FARMING PREDICTS TIGHT NORMS

Table S8B

Are Historical Measures of Modernization Better Predictors of Tight Norms?

|                      | \( B/\gamma \) | SE  | t     | P     |
|----------------------|----------------|------|-------|-------|
| Male                 | 0.001          | 0.013| 0.11  | 0.912 |
| Age                  | 0.001          | 0.001| 1.58  | 0.114 |
| % Employed in Private Industry 1995 | 4.00       | 0.95 | 4.21  | <0.001 |
| Male                 | 0.003          | 0.013| 0.22  | 0.824 |
| Age                  | 0.001          | 0.001| 1.43  | 0.152 |
| Log GDP per Capita 2008 | 0.19       | 0.03 | 5.33  | <0.001 |
| % Employed in Private Industry 1995 | -0.27     | 1.15 | -0.23 | 0.816 |
| Male                 | 0.002          | 0.013| 0.19  | 0.852 |
| Age                  | 0.001          | 0.001| 1.48  | 0.138 |
| Log GDP per Capita 2008 | 0.34       | 0.06 | 5.41  | <0.001 |
| % Employed in Private Industry 1995 | -1.11     | 1.23 | -0.91 | 0.368 |
| % Urban              | -0.74          | 0.25 | -2.93 | 0.004 |
| % Cultivated Land    | 0.15           | 0.11 | 1.38  | 0.170 |
| % Rice               | 0.13           | 0.04 | 2.97  | 0.004 |
| Male                 | 0.001          | 0.012| 0.09  | 0.928 |
| Age                  | 0.001          | 0.001| 1.91  | 0.056 |
| Log GDP per Capita 1995 | 0.18       | 0.02 | 7.61  | <0.001 |
| Male                 | 0.001          | 0.012| 0.10  | 0.920 |
| Age                  | 0.001          | 0.001| 1.89  | 0.059 |
| Log GDP per Capita 2008 | 0.07       | 0.07 | 0.96  | 0.338 |
| Log GDP per Capita 1995 | 0.12       | 0.07 | 1.70  | 0.092 |

Note: GDP statistics are log transformed. Urbanization is the percentage of urban residents per province in 2017. Private employment is an alternative measure of modernization. These statistics from the 1990s represent time-lagged, historical measures of modernization.
### Table S8C

*Are Alternative Measures of Modernization Better Predictors of Tightness?*

|        | $B/\gamma$ | SE  | t    | P   | $B/\gamma$ | SE  | t    | P   | $B/\gamma$ | SE  | t    | P   |
|--------|------------|-----|------|-----|------------|-----|------|-----|------------|-----|------|-----|
| Male   | 0.001      | 0.012 | 0.09 | 0.928 | 0.001      | 0.012 | 0.05 | 0.960 | 0.001      | 0.012 | 0.05 | 0.960 |
| Age    | 0.001      | 0.001 | 1.90 | 0.057 | 0.001      | 0.001 | 1.94 | 0.052 | 0.001      | 0.001 | 1.94 | 0.052 |
| GDP per Capita | 0.005 | 0.001 | 6.50 | < 0.001 | 0.004 | 0.001 | 5.46 | < 0.001 | 0.004 | 0.001 | 5.52 | < 0.001 |
| Male   | 0.001      | 0.012 | 0.10 | 0.924 | 0.001      | 0.012 | 0.05 | 0.958 | 0.001      | 0.012 | 0.06 | 0.956 |
| Age    | 0.001      | 0.001 | 1.87 | 0.061 | 0.001      | 0.001 | 1.94 | 0.053 | 0.001      | 0.001 | 1.94 | 0.053 |
| Log GDP per Capita | 0.18   | 0.02  | 7.40 | < 0.001 | 0.19  | 0.03  | 6.03 | < 0.001 | 0.20  | 0.03  | 6.12 | < 0.001 |

| GDP per Capita 2008 | GDP per Capita 2012 | GDP per Capita 2015 |
|---------------------|---------------------|---------------------|
| Note: Time-lagged GDP per capita is a stronger predictor (with larger t values) of social norms than the concurrent GDP statistics from 2015 (used in the original study). Log GDP (bottom) tends to predict more strongly than regular GDP (top). |
# RICE FARMING PREDICTS TIGHT NORMS

Table S9

*Rice-Wheat Differences Are Robust to Alternative Nesting and Excluding non-Han Provinces*

| Nested in Provinces (Survey Fixed Effects) | $B/\gamma$ | SE  | $t$   | $P$  |
|-------------------------------------------|-----------|-----|------|------|
| Male                                      | 0.0004    | 0.0125 | 0.03 | 0.975|
| Age                                       | 0.002     | 0.001 | 2.25 | 0.024|
| Survey Round 2                            | 0.18      | 0.02 | 12.10 | < 0.001|
| Survey Round 3                            | 0.16      | 0.01 | 10.80 | < 0.001|
| GDP per Capita                            | 0.34      | 0.07 | 5.08 | < 0.001|
| % Urban                                   | -0.80     | 0.28 | -2.92 | 0.008|
| % Cultivated Land                         | 0.15      | 0.13 | 1.20 | 0.243|
| % Rice                                    | 0.12      | 0.05 | 2.47 | 0.022|

| Excluding Non-Han Provinces               | $B/\gamma$ | SE  | $t$   | $P$  |
|-------------------------------------------|-----------|-----|------|------|
| Male                                      | -0.004    | 0.013 | -0.29 | 0.772|
| Age                                       | 0.002     | 0.001 | 2.43 | 0.015|
| Survey Round 2                            | 0.18      | 0.22 | 0.82 | 0.414|
| Survey Round 3                            | 0.15      | 0.22 | 0.71 | 0.480|
| GDP per Capita                            | 0.39      | 0.07 | 5.53 | < 0.001|
| % Urban                                   | -0.96     | 0.29 | -3.31 | 0.001|
| % Cultivated Land                         | 0.01      | 0.12 | 0.12 | 0.905|
| % Rice                                    | 0.10      | 0.04 | 2.45 | 0.017|

Note: GDP per capita is 2008 log-transformed RMB. Urbanization is the percentage of urban residents per province in 2017. Survey rounds are dummy coded with Round 1 as the reference category.
Table S10
**Rice Predicts Tighter Norms Across Nations Beyond GDP, Development, and Historical GDP**

| Norm Tightness Around the World                  | $B/\gamma$ | SE  | t     | P     |
|-------------------------------------------------|------------|-----|-------|-------|
| % Rice Harvested Area                           | 5.71       | 1.69| 3.38  | 0.002 |
| Log 2011 GDP per Capita                         | -0.82      | 0.65| -1.26 | 0.218 |
| % Rice Harvested Area                           | 5.18       | 1.63| 3.17  | 0.004 |
| UN Human Development Index                      | -7.42      | 3.75| -1.98 | 0.058 |
| % Rice Harvested Area                           | 4.61       | 1.85| 2.49  | 0.019 |
| 1950 GDP per Capita                             | -0.29      | 0.21| -1.40 | 0.173 |

Note: Rice statistics represent the percentage of cereal production area harvested with rice in the year 2000. GDP per capita from 2011 is in units of $10,000 international dollars log transformed, accounting for purchasing power parity. The 1950 GDP per capita data is in units of $1,000. The Human Development Index data incorporates health, education, and economic data from 2010. Tightness-looseness scores come from Gelfand and colleagues’ study of 32 nations (5).
Table S11

*Subsistence Styles Predict Tight Norms Across Societies Beyond Modern GDP, Historical GDP, and Development*

| Norm Tightness Around the World | β/γ | SE  | t    | P    |
|---------------------------------|-----|-----|------|------|
| Interdependent Subsistence Style Index | 4.20 | 1.56 | 2.70 | 0.011 |
| Log 2011 GDP per Capita          | -0.46 | 0.69 | -0.67 | 0.510 |
| Interdependent Subsistence Style Index | 3.75 | 1.53 | 2.45 | 0.020 |
| UN Human Development Index       | -6.59 | 4.04 | -1.63 | 0.113 |
| Interdependent Subsistence Style Index | 3.79 | 1.82 | 2.08 | 0.047 |
| 1950 GDP per Capita              | -0.28 | 0.22 | -1.24 | 0.224 |

Note: Rice statistics represent the percentage of cereal production area harvested with rice in the year 2000. GDP per capita from 2011 is in units of $10,000 international dollars, accounting for purchasing power parity. The 1950 GDP per capita data is in units of $1,000. The Human Development Index data incorporates health, education, and economic data from 2010. Tightness-looseness scores come from Gelfand and colleagues' study of 32 nations (5).
Table S1

Rice and Subsistence Styles Predict Tight Norms in China and Worldwide Beyond Differences in Collectivism

|                        | China                        |                             |     |     |     |      |
|------------------------|------------------------------|------------------------------|-----|-----|-----|------|
|                        | B/γ  | SE   | t    | P    |     |      |
| Male                   | 0.03 | 0.02 | 1.42 | 0.156|     |      |
| Age                    | 0.003| 0.001| 1.91 | 0.056|     |      |
| GDP per Capita         | 0.27 | 0.07 | 3.60 | 0.001|     |      |
| % Urban                | -0.007| 0.003| -2.39| 0.025|     |      |
| % Rice                 | 0.19 | 0.05 | 3.63 | 0.001|     |      |
| In-Group Collectivism  | 0.14 | 0.01 | 12.62| < 0.001|     |      |
| Male                   | 0.04 | 0.02 | 1.54 | 0.124|     |      |
| Age                    | 0.001| 0.001| 0.89 | 0.372|     |      |
| GDP per Capita         | 0.27 | 0.08 | 3.62 | 0.001|     |      |
| % Urban                | -0.007| 0.003| -2.13| 0.043|     |      |
| % Rice                 | 0.18 | 0.05 | 3.24 | 0.003|     |      |
| Relational Collectivism| 0.04 | 0.01 | 4.09 | < 0.001|     |      |

|                        | Worldwide                      |                             |     |     |     |      |
|------------------------|--------------------------------|------------------------------|-----|-----|-----|------|
|                        | B/γ  | SE   | t    | P    |     |      |
| % Rice Harvested Area  | 4.64 | 1.46 | 3.19 | 0.004|     |      |
| Ingroup Collectivism   | 1.11 | 0.54 | 2.08 | 0.049|     |      |
| % Rice Harvested Area  | 4.74 | 2.01 | 2.36 | 0.025|     |      |
| Individualism (Hofstede)| -0.02| 0.02 | -0.77| 0.446|     |      |
| Interdependent Subsistence Style Index | 4.01 | 1.40 | 2.86 | 0.009|     |      |
| Ingroup Collectivism   | 1.34 | 0.54 | 2.48 | 0.021|     |      |
| Individualism (Hofstede)| -0.03| 0.02 | -1.45| 0.158|     |      |

Note: We encourage readers to interpret these analyses carefully, because collectivism is also a plausible consequence of rice and the subsistence style index. These analyses suggest that rice may cause differences in norm tightness beyond the effects of collectivism, at least as collectivism is measured in these survey items. In our prior writings, we have raised the possibility that survey items measuring collectivism may not capture the type of tight, duty-bound culture of rice villages (13, 14). Collectivism values in China come from survey items administered in the earlier study on norm tightness (2). International collectivism data come from the GLOBE study (15), and individualism values come from Hofstede's international studies of individualism (16). China GDP data is log RMB from 2008. Urbanization in China is the percentage of urban residents per province in 2017. Worldwide Rice statistics represent the percentage of cereal production area harvested with rice in the year 2000.