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Ostrom Meets the Pandemic: Lessons from Asian Rice Farming Traditions*

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Abstract

A robust public health system during a pandemic is a common good. We argue that the ongoing coronavirus pandemic is a tragedy of the commons. During the early phases of the pandemic, Asia outperformed the US and Europe in managing it. The traditions and practices of rice farming in Asian countries are key to understanding the regional differences. Farming rice, unlike wheat, requires finding cooperative solutions to common goods problems such as irrigation. The history of rice cultivation in Asia implies that those societies have long had institutions that deal well with the commons through credible commitment, mutual monitoring, and sanctions. The descendants of Asian rice farmers commit themselves to a set of rules and are vigilant in monitoring their neighbors in common goods situations because they fear social rejection if they do not. Exploiting Asian immigration history in the US and the pandemic as a natural experiment, and using a patient-level CDC dataset, we show that Asian rice farming descendants are less likely to contract and/or die from the coronavirus even in the US. Then, using a Facebook survey, Google mobility data, and the US Census household pulse survey, we find that they were better able to resolve commons problems associated with the pandemic by getting vaccinated, wearing masks, and practicing social distancing.

Keywords: Asian Immigration, CDC, Common Goods, Culture, Elinor Ostrom, Institutions, Mask Wearing, Pandemic, Rice Farming, Social Distancing, Social Rejection
JEL Codes: D70, N32, Q10, Z13

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What is common to the greatest number has the least care bestowed upon it.
Everyone thinks chiefly of his own, hardly at all of the common interest.
– Aristotle, *Politics*

1 Introduction

In his book *Orientalism*, Edward W. Said noted that the West's depiction of the East is generated not through actual facts, but through imaginary constructs. In most cases, Westerners' interpretation of the East is constructed as the antithesis of the West. For example, it has long been documented that Eastern cultures tend to be collectivistic whereas Western cultures tend to be individualistic (e.g., Markus and Kitayama, 1991; Triandis, 1995; Nisbett et al., 2001).

Because the collectivism-individualism cleavage has been widely studied in social sciences, it is possible to be caught in the fallacy of a false dilemma when in fact there are other possibilities. This dichotomous thinking may even lead to thinking of the East as *irrational*, depraved, childlike, and different and the West as *rational*, virtuous, mature, and normal (Said, 1978). Furthermore, the terminology portraying the East as collectivistic may mislead researchers into twisting some findings about the East to suit the theory, instead of letting the facts prove or disprove the theory (Doyle, 1895).

From an economist's perspective, it would be problematic to envision two sets of human agents with different human natures – Eastern people as *collectivistic* and Western people as individualistic. Instead, both Westerners and Easterners are self-interested agents who solve optimization problems according to their own circumstances. The differences in human behavior between the East and the West reflect the fact that self-interested agents respond to their different environments, not because one is individualistic and the other is collectivistic.

Here, from our economist's standpoint, we investigate the fundamental determinants of differences in some human behavior between the East and the West. To do so, we go back in history to the Neolithic (or Agricultural) Revolution approximately 10,000 years ago. Because the agricultural sector dominated economic production prior to the Industrial Revolution, this historical approach provides us with some clues to the origin of differences in human behavior between the East and the West (Harari, 2014). Agro-ecological constraints have shaped the geographical distribution of staple crops between the East and West such that rice has been a staple crop in Asia and wheat in Europe. Asian countries are in general ideal environments for rice cultivation; European countries do not have either warm or humid enough climates for rice farming.

We argue that institutions developed in Asian rice farming areas are key to understanding differences in human behavior between the East and the West. Fundamentally, farming rice requires solutions to *common goods problems*.[1] Talhelm et al. (2014) pointed out that irrigation and massive labor requirements are two unique features of Asian rice farming, which distinguishes it from rain-fed wheat farming in Europe. A village-wide irrigation system in drought is a common good because it is non-excludable and rival. In rice farming, self-interested farmers have every incentive to appropriate water for their own benefit (i.e., the appropriation problem). Also, they have every incentive to devote as little time as possible to developing and maintaining an irrigation system by free-riding off the common good created by their neighbors (i.e., the provision problem).[2] Extensive rice cultivation in Asia reflects the fact that those societies have had distinctive institutions for dealing with the commons.

We conjecture that Eastern cultures formulated certain types of institutions to solve commons problems in rice farming. Ostrom (1990) found that groups and societies that dealt successfully with commons problems throughout history have operated with two common institutional mechanisms: (i) *credible commitment* (to obtain long-term reciprocal benefits by committing to a set of rules) and (ii) *mutual monitoring and subsequent sanctions* (according to a set of rules formulated by in-group members). We argue that in Asian rice farming areas, where solutions to common goods problems are crucial for sustaining rice cultivation, self-interested farmers must have committed themselves to a set of mutually agreed principles in common goods situations.

We emphasize that the fear of social rejection is key to understanding the East. In Asian rice farming areas, to manage the commons, farmers kept track of each person's work assignments and punished farmers who failed to show up. If farmers were uncooperative or failed to fit in, they could even be excluded from social life (ostracized). Fearing ostracism, farmers in Asian rice farming areas committed credibly to a set of rules in commons situations.

The Asian rice farming traditions persist in Asian rice farming societies, especially in commons situations. Over time, social norms of mutual monitoring and subsequent sanctions have created in-group vigilance and have exerted a substantial influence on human behavior (Benedict, 1946); they act as strong social control mechanisms in present-day Asian rice farming areas.[3] Looking through a economist's eyes at the rice farming,

[1] In economics, common goods are both *nonexclusive* and *rival*; they are subject to the tragedy of the commons when they are overexploited.

[2] Please note that the appropriation problem can arise only when the commons become scarcer (i.e., common goods cases), whereas the provision problem can occur if goods are nonexclusive such as public goods. Please refer to Appendix A. What Is a Common Good? for more details.

[3] Hagen and Choe (1998) argue that ostracism would be a particularly severe penalty in Japan, and this

one can still regard people as self-interested individuals, consistent with an economics perspective, not as collectivistic individuals; at the same time, these traditions can potentially explain the differences in human behavior between the East and the West.

We thus hypothesize that present-day Asian rice farming descendants are more likely to follow government mandates and more likely to be vigilant in observing their neighbor in commons situations for fear of being rejected socially if they do not. Hence, appropriation and provision problems could be managed better in contemporary Asian rice farming regions to avoid a tragedy of the commons.

A natural question arises at this point: how do we test our hypothesis empirically? The ongoing coronavirus pandemic provides us with a natural experiment. We first argue that public health in normal times is a public good; *public health in pandemics*, however, is a common good. Therefore, in this pandemic situation, we encounter (i) provision problems and (ii) appropriation problems, just as in farming rice. Achieving herd immunity through vaccinations is an example of the provision problem. Self-interested individuals may prefer not to be vaccinated and to free ride off the herd immunity created by those who are immune. The appropriation problem is exemplified by self-interested individuals who choose not to wear a mask or socially distance themselves without consideration of the risk of transmitting the virus to others.

A cross-country comparison supports this hypothesis. The share of confirmed Covid deaths and cases in the population was much lower in East Asian countries than in the US and European countries as of August 31, 2021.[4] To put it another way, East Asian countries better managed the commons than the US and European countries did. Although this cross-country analysis supports our hypothesis, it suffers inherently from endogeneity issues because countries' characteristics differ. Further, the observed differences between regions do not necessarily mean that Asian rice farming descendants are more likely to adhere to government mandates and to monitor their neighbors in commons situations.

Here, we overcome these issues by using the history of Asian immigration in the US over the past six decades as a natural experiment. Unlike the history of immigration

induces people to value group membership and makes people more loyal to groups they belong to. Kimel et al. (2017) say that sanctioning in Japan works as a powerful social instrument for reducing cheating. Bullying continues to be a social problem in Japan (Akiba, 2004; Naito and Gielen, 2005). Some studies note that ostracism is considered to be a much harsher penalty in Japan than in the US and other Western countries (Kanetsuna et al., 2006; Williams, 2007; Ramseyer and Rasmusen, 2020). In the literature on public good experiments, Maier-Rigaud et al. (2010) find that introducing ostracism increases contributions to public goods.

[4]During the early phase of the pandemic, in April 2020, Sachs (2020) observed a similar pattern: East Asian countries were outperforming the United States and Europe in controlling the pandemic.

from Europe and Africa, which began as early as the sixteenth century, mass immigration from Asia started less than 60 years after the Immigration and Nationality Act of 1965 that eliminated the national origins quota system. These more recent immigrants from Asia are therefore more likely to possess cultural traits that are similar to those in rice farming Asian countries.[5] In addition, Asian migrants to the US have tended to settle near one another and to cluster within their own communities;[6] many earlier studies have documented that Asian immigrants in the US strive to maintain their cultural traditions.[7] Therefore, instead of comparing people across countries, our focus on the US allows us to control for confounding country characteristics.

We first test whether Asian rice farming descendants outperformed others in managing public health amid the pandemic, thereby avoiding a tragedy of the commons. To be specific, using the patient-level CDC data, we test whether Asians in the US are less likely to be infected by and to die from the Covid virus. We calculate the share of Asian Covid deaths and cases in each county, and the share of Asian populations in each county. We found that Asians are 29 percent less likely to die of Covid and 45 percent less likely to contract Covid, suggesting that Asian rice farming descendants better managed public health amid the pandemic – i.e., the commons. If the US had operated under an institutional mechanism that resolved the commons problems, 183,013 US residents' lives would have been saved and 17,154,891 fewer people would have contracted Covid as of Aug. 30, 2021.

Next we test whether Asian rice farming traditions can be correlated with a more effective response to the commons problems in the pandemic. That is, we test whether provision (e.g., free-riding on vaccinations) and appropriation problems (e.g., choosing "individual freedom" over social distancing and mask wearing) were better managed among Asian rice farming descendants in the pandemic. To do so, we use three high-quality datasets, (i) Delphi's Covid-19 Trends and Impact Survey (CTIS) data from Facebook, (ii) US Census Household Pulse Survey (HPS) data, and (iii) the Covid-19 Community Mobility Reports database from Google, to measure behavioral responses, as well as the beliefs and norms that influence them, among Asian rice farming descendants and others, which capture credible commitment and mutual monitoring regarding appropriation and provision problems in commons situations (e.g., vaccination, mask wearing, and

[5] In addition, a vast majority of Asian Americans have actually come from rice farming areas in Asia.

[6] Using the US Census tract-level data, we measure the dissimilarity index and find that roughly 50 percent of Asians would have to move to a different neighborhood, i.e., Census tract, to achieve an even distribution between Whites and Asians.

[7] Examples include Triandis (1990); Kibria (1994); Whyte (1998); Coon and Kemmelmeier (2001); Bisin et al. (2004); Almond and Edlund (2008); Abrevaya (2009); Almond et al. (2013); Poudel-Tandukar et al. (2019); Blau et al. (2020); Ma et al. (2020a); Giuliano and Nunn (2021).

social distancing) in the US.

We find that Asian farming descendants are more likely to commit themselves to a set of government mandates and monitor their neighbors in commons situations because they fear social rejection if they do not. To be specific, first, we find that Asian rice farming descendants are more likely to spend their own resources on vaccination to achieve herd immunity in the common goods situation, thereby better resolving the *provision* problem. Second, we find that rice farming descendants are more likely to wear masks and engage in social distancing in order to curb the spread of Covid, thereby better addressing the *appropriation* problem. Taken together, the traditional behaviors of Asian rice farmers, not collectivism, operated as a strong social control mechanism in Asian rice farming areas; it persists today and plays a major role in managing the commons.

1.1 Related Literature

Our work is most closely related to the analysis of economic governance, especially the commons. Ostrom (1990) revisited the so-called "tragedy of the commons" as described by Hardin (1968). Hardin conjectured that Malthusian catastrophe is inevitable in commons situations. Ostrom, however, demonstrated that the "tragedy" in such situations in the real world isn't inevitable by explaining how local property can be successfully managed without any regulation by central authorities or privatization. Since then, in economics, theoretical studies have attempted to describe the problem of the commons in different game-theoretical settings (Tarui, 2007; Alix-Garcia, 2008; Montero, 2008; Nitzan and Ueda, 2009; Hassan and Mertens, 2011; Costello et al., 2015; Sabouni and Shelton, Forthcoming). Building on theoretical predictions, many empirical studies have validated those predictions (Dayton-Johnson, 2000; Ostrom, 2002; Cardenas, 2003; Ostrom, 2006; Rodriguez-Sickert et al., 2008; Gillet et al., 2009; Prediger et al., 2011).[8] The majority of previous economics literature had typically focused on natural, environmental, and infrastructural resources in commons situations.

Unlike the previous economic studies on this topic, we focus on public health in pandemics and define it as a common good. Notwithstanding the fact that some earlier studies in the public health literature have attempted to link public health and the commons (Siegal et al., 2009; Cully, 2014; Ram-Tiktin, 2018), to our best knowledge no studies have yet delineated the fundamental economic characteristics of public health in a pandemic. Adopting the concept of a rival good in economics, we contribute to the literature by

[8] We refer the interested readers to the literature reviews on the common good problems in natural resources (Stavins, 2011), in environment (Nordhaus, 2014), and in public policies and commons governance (Frischmann et al., 2019).

clearly differentiating public health in a pandemic (i.e., a common good) from public health in normal times (i.e., a public good). Furthermore, applying the common goods framework to the current Covid-19 situation, we show that traditional Asian rice farming practices can be credited with better addressing commons issues in a pandemic. Thus these empirical findings contribute one additional piece of evidence to the empirical literature on common goods problems.[9]

This study complements the literature investigating the agrarian origins of individualism and collectivism.[10] Olsson and Paik (2016) find that regions which adopted agriculture early are characterized by collectivist values. Ang (2019) finds that agricultural legacy of a more labor intensive environment is associated with modern-day collectivistic traits. Buggle (2020) and Buggle and Durante (2021) suggest that the coordination of labor required by irrigation systems is associated with collectivist cultures. Fiszbein et al. (2022) find that agricultural labor intensity is positively associated with collectivism. Talhelm et al. (2014) argue that a history of farming rice makes cultures more interdependent.

These previous studies advanced our understanding of the origins of individualism and collectivism. It is still unclear, however, what different mechanisms rational agents use to solve an optimization problem. In this paper, building on the rice theory of Talhelm et al. (2014), we interpret the issues arising from farming rice as common goods problems. Looking through an economist's eyes at rice farming since the Neolithic Revolution, one can still regard people as self-interested rather than collectivist, at the same time, it is possible to explain why people in Eastern and Western cultures behave differently from each other. To be specific, relying on Ostrom (1990), we suggest a novel mechanism such that: (i) institutions have dealt with commons problems in rice farming via credit commitment, mutual monitoring, and sanctions; and (ii) those institutions have shaped economic agents' behaviors over time.

This study is related to a rich literature on cultural persistence. One group of studies documents the persistence of cultural traits over generations (e.g., Fischer, 1989; Fernandez, 2007; Giuliano, 2007; Fernández and Fogli, 2009; Algan and Cahuc, 2010; Nunn and Wantchekon, 2011; Voigtländer and Voth, 2012; Spolaore and Wacziarg, 2013; Guiso et al., 2016).[11] Another group of studies documents the determinants of cultural persistence.

[9] Unlike previous empirical approaches to commons problems, which have been conventionally conducted as small-scale laboratory experiments, we exploit a natural experiment provided by the pandemic and the history of Asian immigration to the US to empirically analyze the commons problems.

[10] There are also studies investigating the non-agrarian roots of individualism-collectivism (e.g., Greif, 1994; Fincher et al., 2008; Gorodnichenko and Roland, 2011, 2017; Bazzi et al., 2020, 2021).

[11] These examples support cultural transmission models, originally adopted from evolutionary anthropology, that serve as a foundation for cultural persistence in cultural economics (e.g., Bisin and Verdier,

Examples include Diamond and Ordunio (1999); Voigtländer and Voth (2012); Bazzi et al. (2020); Giuliano and Nunn (2021). Among the many factors of cultural persistence, several studies focus on historical farm practices in agricultural production (e.g., Alesina et al., 2011, 2013; Galor and Özak, 2016; Litina, 2016; Ager and Ciccone, 2018). Building on this strand of the literature, we identify one additional piece of evidence of agrarian cultural persistence: the traditional behaviors associated with Asian rice farming that were used in dealing with commons problems persist to this day. In particular, we show that Asian rice farming descendants are well suited to addressing the commons problem in a pandemic.

This study also contributes to a burgeoning literature showing that cultural factors explain differential performance in managing the pandemic. It has been documented that cultural traits, such as ethnicity ((Debnam Guzman et al., 2022), social trust (Bargain and Aminjonov, 2020), social capital and community engagement (Ding et al., 2020), and civic capital (Durante et al., 2021), may account for differential responses to public health policies such as social distancing, vaccination, and mask use, which are again highly related to the pandemic outcomes. Another cultural factor that has drawn attention is the individualism-collectivism spectrum. Some studies document that (rugged) individualism led to government intervention less effective (Bazzi et al., 2021; Chen et al., 2021; Bian et al., 2022). In a similar vein, Talhelm et al. (2022) find that tight social norms originating from traditional rice farming yielded more successful Covid-19 outcomes.

Here we provide complementary evidence that sheds light on the mechanism behind the previously documented link between cultural traits and behaviors in curbing the pandemic. In particular, we go beyond the previous studies by explaining the East-West divide in the pandemic, a puzzling observation that is still poorly understood (see Sachs, 2020). Here, (i) we suggest that a novel mechanism, the tradition and practices of Asian rice farming, played a crucial role in managing the commons (i.e., public health in a pandemic); (ii) we develop a new identification strategy that exploits large-scale immigration from Asia to the US after the Immigration and National Act of 1965; and (iii) we use a set of confidential, behavioral, and individual-level datasets to validate the hypothesis.

The paper is organized as follows. Section 2 characterizes the tragedy of the commons in rice farming. Section 3 defines public health in pandemics as a common good. Section 4 describes Asian immigration history in the US. Section 5 describes the four primary data sources used in the empirical analysis. Section 6 presents our empirical findings connecting managing the commons with Asian rice farming traditions. Section 7 presents

2000, 2001; Hauk and Saez-Marti, 2002; Francois and Zabojnik, 2005; Tabellini, 2008; Greif and Tadelis, 2010; Bisin and Verdier, 2017; Doepke and Zilibotti, 2017).

evidence on behavioral responses to the commons problem in a pandemic. Section 8 concludes.

2 The Tragedy of the Commons in Rice Farming

2.1 Rice Farming through an Economist's Eyes

Before the Industrial Revolution, the agricultural sector dominated economic production for 10,000 years. Producing staple crops was the central part of everyone's life. One notable geographical pattern is that rice has supported human populations in Asia, whereas wheat has been the basic staple food of major civilizations in Europe (Silva et al., 2015; Civáň et al., 2015). This pattern still persists in the modern agrarian economics (see Figure 1).[12] What accounts for this difference between the two region?

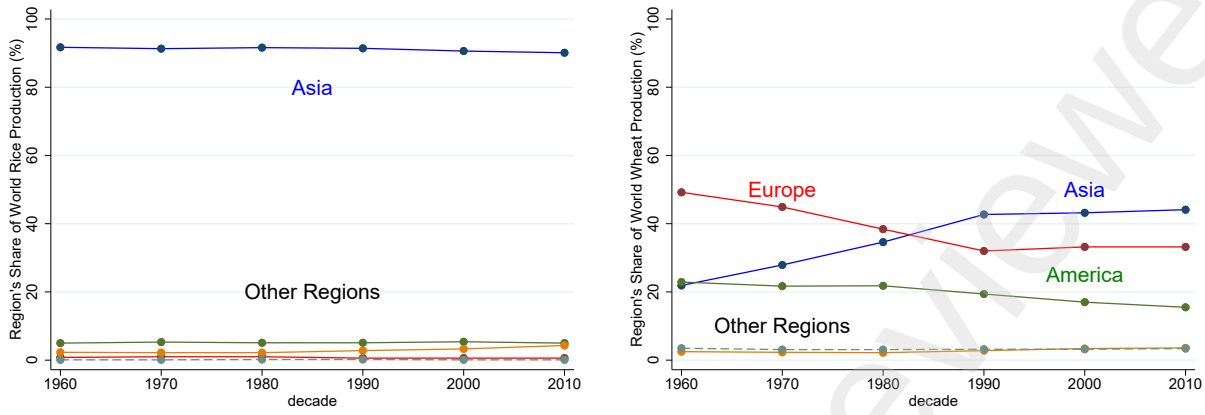
Historically, agro-ecological constraints have shaped the geographical distribution of staple crops. The current scientific consensus is that domesticated rice production originated in the Yangtze River basin in China (Normile, 1997; Vaughan et al., 2008; Zhang et al., 2012; Silva et al., 2015). Although migration and trade spread rice around the world, rice production was limited, especially in Europe and the Middle East (Purugganan and Fuller, 2009) because the ideal environment for rice cultivation is primarily in warm and humid year-round climates of eastern, southeastern, and southern Asia (Huke, 1976).[13]

More important, we argue that another essential requirement needed for rice farming is an *institution* that can resolve common goods problems. Talhelm et al. (2014) pointed out that irrigation and massive labor requirements are two key features of rice farming, which distinguishes it from wheat farming. Because paddy rice needs standing water, farmers in rice regions need to build irrigation systems. In irrigation networks, one family's water use can affect their neighbors', which requires rice farmers to coordinate their water use. Rice also requires an extraordinary amount of labor. To deal with the mas-

[12] Figure B.1 presents the geographical distribution of the share of rice production among staple crops by country in 2000. For all Asian countries located to the east of Pakistan (23.6 percent), the shares of rice production among staple crops are more than 40 percent: Bhutan (41.5 percent), China (46.4 percent), and India (54.3 percent) for three lowest ranked and Sri Lanka (98.8 percent), Malaysia (97.1 percent), and South Korea (96.8 percent) for three highest ranked. This pattern is in stark contrast to the case in the Western countries. Portugal ranked first among European countries, but its share is only 8.8 percent. Then, Italy (6.0 percent), Spain (3.4 percent), Greece (2.8 percent), and Turkey (1.1 percent) followed Portugal. For all other European countries, their shares of rice were less than 1 percent. While both Figures 1 and B.1 present the data based on the modern era, the agricultural age was not much different (Huke, 1976; Vaughan et al., 2008; Purugganan and Fuller, 2009).

[13] In contrast, wheat was first cultivated in the southern Levant, the regions of the Fertile Crescent, around 9600 BC, and spread through the Mediterranean and central Europe (Colledge and Conolly, 2007; Zohary et al., 2012). Since then, wheat has been the basic staple food in Europe.

Figure 1: Rice and Wheat Production around the World



(a) Rice Production Share

(b) Wheat Production Share

Notes: This figure reports the aggregated production patterns for rice and wheat for the period 1961-2019 by region. Each point estimate is the 10-year average. The production data are sourced from the Food and Agriculture Organization of the United Nations (FAO) FAOSTAT Database. We use the rice product code corresponding to "FAOSTAT 0027" (i.e., HS code 1006.10; SITC REV.2 code 042.1) and the wheat product code corresponding to "FAOSTAT 0015" (i.e., HS code 1001; SITC REV.3 code 041). Data on both commodities are for crops harvested for dry grain only, excluding crops harvested for feeding animals.

sive labor requirements, farmers in a rice community form cooperative labor ex- changes during the periods of transplanting and harvesting. In contrast, wheat is much easier to grow. Since wheat can rely on rainfall, wheat farmers do not need to coordinate with their neighbors. Planting and harvesting wheat requires labor, but only half as much as rice, which allows wheat farmers to care for their own crops without relying on their neighbors.[14]

Building on the rice theory of Talhelm et al. (2014), we now look at rice farming through an economist's eyes. We argue that the need for irrigation and cooperative labor in rice farming requires finding solutions to common goods problems.[15] Water from irrigation in a period of drought is a common good because it is nonexcludable and rival, which involves appropriation and provision problems.[16] Self-interested farmers have every incentive to use water for their own benefits; and they are more likely to spend less time on developing and maintaining an irrigation system if they can free-ride on the ir-

[14] Talhelm et al. (2014) proposed their rice theory based on the difference between rice farming in Asia and wheat farming in Europe. The history of farming rice in Asia made cultures more interdependent, whereas wheat farming in Europe made cultures more independent. Moreover, these agricultural traditions continue to affect people in the modern world.

[15] In this paper, we assume explicitly that rice farmers are self-interested economic agents.

[16] Please refer to Appendix A. What is a Common Good? for more explanation about common goods.

rigation systems created by their neighbors. Likewise, rice requires massive collective action during transplanting and harvesting, which must be done in a short period of time. Self-interested farmers have every incentive to provide as little of their own labor as possible and will try to benefit from the collective work done by their neighbors.

In the absence of institutions that address the commons problems in rice farming, rice could not have been an equilibrium crop over 13,500 years. In other words, rice cultivated extensively in Asia reflects the fact that those societies have had distinct institutions dealing with the commons. Self-interested rice farming ancestors in Asia must have solved common goods problems as a first priority to maintain their livelihood and must have been required to comply with institutional rules. We envision that, as Ostrom (1990) pointed out, those institutions would have been self-governed and self-organized, rather than private or public.

2.2 Asian Rice Farming Traditions

We posit that those institutions in Asian rice farming areas formulated unique traditions over the years: Asian rice farmers commit themselves to rules set by authorities and monitor the behaviors of their neighbors in dealing with common goods issues. Ostrom (1990) argues that two common mechanisms are necessary to sustain long-term self-governed, self-organized institutions that resolve commons problems: (i) *credible commitment* (commitment to a set of rules in order to obtain long-term collective benefits) and (ii) *mutual monitoring and subsequent sanctions* (according to a set of rules formulated by in-group members).

In rice farming areas, credible commitment to a set of principles is one institutional mechanism for resolving commons problems. Ostrom (1990) states that appropriators prevent the tragedy of commons by committing themselves to self-governed rules in using the commons and contributing to provisioning activities. If everyone follows the self-imposed rules, the scarce resources are allocated more predictably and efficiently, the resource allocation system will be sustained over time (i.e., "the long-term expected net benefits to be achieved by this strategy are greater than the long-term expected net benefits for individuals following short-term benefits" (Ostrom, 1990)). As described in Section 2.1, to survive in rice farming, self-interested farmers have fewer individual choices but make credible commitments without hesitation to the social arrangement of tasks from seed to harvest *for their own long-term gains* (Talhelm and English, 2020). Consequently, rice farming societies have shown 'pro-social' consequences, in particular obedience and loyalty

to their in-group authority (Talhelm, 2020).[17]

Mutual monitoring (and subsequent sanctions) is another mechanism for resolving commons problem in rice farming. Ostrom (1990) argues that commitment and monitoring are tightly linked : without monitoring, there can be no credible commitment. In self-governed institutions where individuals follow rules, appropriators that violate the social norms are likely to be called out by other appropriators and be punished by the society. In a rice farming society with common good problems, farmers kept track of each person's work assignments and punished people who failed to show up (Talhelm et al., 2014). If farmers failed to fit in, punishments could cut deep. Rice farmers also excluded (ostracized) uncooperative farmers from the community's social life.

Credible commitment, mutual monitoring, and sanctions have exerted a substantial influence on human behavior and act as a strong social control mechanism in modern-day Asian rice cultures to manage the commons. People conform to a set of rules in contemporary Asian rice cultures because they are afraid of being ostracized if they do not (Thomson et al., 2018; Talhelm, 2020),[18] not because they are *collectivistic*. As a consequence, social norms of mutual monitoring and sanctions have created in-group cooperation in Asian rice farming societies, and these cultural traits persist today (Liu et al., 2019).

3 The Pandemic: Public Health as a Common Good

3.1 Public Health in Pandemic Is a Common Good

We argue that public health in normal times is a public good; *public health in pandemics*, however, is a common good. A public health system that produces health among the general public is a collective property. No one can be excluded from the benefit of a sound public health system (because it is nonexclusive), and one person benefiting from the system does not preclude others from enjoying similar benefits (it is a nonrival good) (Smith et al., 2003; Horne, 2019).[19] In contrast, public health in a pandemic can be rivalrous. For

[17]Many social psychologists have provided evidence that Asians prefer attitudes and behaviors that support what is best for the society at large–which they believe is good for them–with the belief that group decisions are superior to individual decisions (Hofstede and Bond, 1984; Schermerhorn and Bond, 1997; Parkes et al., 2001; Darwish and Huber, 2003; Basabe and Ros, 2005; Kim, 2017).

[18]Our view is in line with recent studies, including one by Thomson et al. (2018); Talhelm (2020), who argue that traditional rice farming involved cooperation, but not warmth or emotional intimacy. Rice-farming societies trust strangers less, share less personal information, and report less intimacy in relationships than people in societies with high relational mobility.

[19]Public health systems are commonly defined as all public, private, and voluntary entities that contribute to the delivery of essential public health services within a jurisdiction. Public health systems differ

instance, when self-interested individuals do not wear a mask to protect themselves, they also increase the risk of transmitting the virus to others and thus weaken the public health system.[20] Public health in the Covid-19 pandemic is therefore a common good.

Unlike in a public good case (in which provision problems exist but appropriation problems do not), responding to a pandemic gives rise to two commons problems: (i) appropriation problems and (ii) provision problems, just as in rice farming. First, let us focus on provision problems in the pandemic. Public health is nonexclusive both in normal times and in a pandemic; provision problems are not specific to a pandemic. Herd immunity through vaccinations is a case in point. In normal times, most countries recommend a series of vaccinations to protect people from infectious diseases. During the Covid-19 pandemic, after the development of Covid-19 vaccines, most countries rolled out vaccination programs. In both circumstances, the goal of getting vaccinated is to protect oneself and to achieve herd immunity.[21] Just as in a public good case, herd immunity is vulnerable to the free-rider problem. Self-interested individuals may choose not to be vaccinated and to free-ride off the herd immunity created by those who are immune. But the free-riding behavior will prevent the herd immunity.

Table 1: Characteristics and Problems of Common Goods: Three Examples

Common goods:	Onshore Fishery (1)	Irrigation in Drought (2)	Public Health in a Pandemic (3)
Panel A. Characteristics			
Nonexclusive	No fisher is excluded from fishing.	No farmer is excluded from the irrigation.	No one is excluded from the benefits of public health.
Rival	As people withdraw fish, the stocks for later fishermen are depleted.	One family's water use can affect their neighbors' water use.	Individual freedom can increase the risk of virus transmission.
Panel B. Problems			
Appropriation	A self-interested fisher has every incentive to overfish.	A self-interested farmer has every incentive to overuse water in an irrigation system.	A self-interested individual has every incentive to seek for individual freedom.
Provision	To maintain sustainable fish stocks.	To develop and maintain irrigation systems.	To develop herd immunity in a society.

Next, we turn our attention to appropriation problems in a pandemic. When public health becomes scarce, unlike in normal times, appropriation problems can arise. Refusal to wear a mask or to engage in social distancing are two examples. When a self-

from private health care systems that are provided through for profit-seeking industries (Basu et al., 2012).

[20] In other words, from an economic perspective, public health becomes scarcer in pandemics.

[21] Herd immunity is a form of indirect protection from infection conferred to susceptible individuals when a sufficiently large proportion of immune individuals exist in a population (Randolph and Barreiro, 2020).

interested individual chooses the degree of social distancing or mask wearing to participate in, he/she considers the personal benefits and costs only, not the social benefits and costs. While practicing social distancing or mask wearing may not generate social benefits or costs in normal times (i.e., nonrivalrous behavior), in a pandemic they can greatly decrease the risk of transmitting the virus to everyone (i.e., rivalrous behavior). Hence, in the pandemic, when public health becomes a scarce resource in common, if self-interested individuals do not practice social distancing (or mask wearing) for their own benefit, then it will lead to the degradation (and collapse) of the public health system (i.e., the tragedy of the commons). In Table 1, we summarize the characteristics and problems of common goods using three examples: (i) onshore fishery; (ii) irrigation in drought; and (iii) public health in a pandemic.

3.2 Implications of Asian Rice Farming Traditions in the Era of Covid

We argue in Section 2.2 that Asian rice farming traditions operated as a strong social control mechanism in Asian countries (and among Asian rice farming descendants) to better resolve the commons problems during the pandemic than the traditions in the US and European countries did. "Privatization" and "Leviathan," both imposed by outside forces, have long been considered as conventional wisdom to solve for the tragedy of the commons (Hardin, 1968; Ophuls, 1973; Johnson, 1972; Demsetz, 1974). In regard to privatization, although the boundaries of other common goods (e.g., meadows, offshore fisheries) can be relatively be well defined to create a system of property rights, it would be impractical and even impossible to define a system of property rights for public health in a pandemic (Kolderie, 1986; Ostrom, 1990; Freyfogle, 2003).

Turning our attention to the Leviathan (e.g., a central agency), although the role of government may explain the differences between the two regions up to a point, we think that it is not a fundamental or complete explanation. Ostrom (1990) argues that, faced with a cooperative-action problem, institutions must resolve two issues: (i) credible commitment and (ii) mutual monitoring.[22] Those two problems are beyond the control of a government unless a central agency has full information, full monitoring capabilities, and full sanctioning authority. In a pandemic, meeting these criteria via government intervention would be even more difficult than in normal times.[23]

[22] That is, individuals in society commit themselves to follow the rules; mutual monitoring of conformance to a set of rules should be addressed.

[23] One may argue that East Asian *governments* have been successful in implementing a series of measures (e.g., mask requirement, vaccinations, social distancing, quarantines, border closings, etc) to curb the spread of Covid-19 viruses, relative to European and North American countries. We cannot rule out this possibility completely, but at least two arguments support the idea that government intervention is not the main dif-

Due to deeply rooted in their rice farming cultures that dealt with commons issues, Asian rice farming descendants are more likely to commit themselves to government mandates (e.g., vaccines, mask wearing, and social distancing) and more likely to cooperate with their neighbors (e.g., engage in mutual monitoring) in common goods situations because they are afraid of being ostracized. Hence, the appropriation (e.g., individual freedom in social distancing and in mask wearing) and provision problems (e.g., free-riding on vaccinations) could have been controlled better in Asia than in the US and Europe, which avoided the collapse of public health systems in the early phases of the pandemic. We thus hypothesize that i) Asian rice farming descendants are less likely to contract and/or die of Covid than Westerners; and that ii) Asian rice farming descendants are more likely to get vaccinated, wear masks, and engage in social distancing, thereby better controlling the appropriation and the provision problems.

3.3 Preliminary Evidence: The East-West Divide in the Pandemic

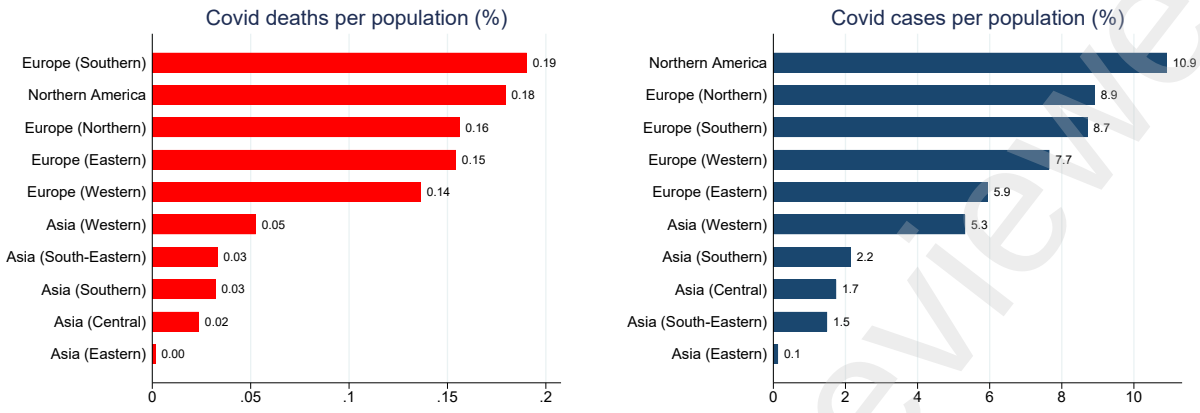
A cross-country comparison weakly supports the first hypothesis (see Sachs, 2020). Figure 2 shows the confirmed Covid deaths and cases by subregion as of Aug 31, 2021. North American and European countries were overwhelmed by the pandemic. In stark contrast, Asian countries kept Covid at more manageable levels. Accordingly, the differences observed in the Covid cases and deaths between the two regions in Figure 2 may indicate that East Asian countries dealt more successfully with the two underlying common goods issues than the United States and Europe.[24] [25]

ference. First, most countries, both East Asian and European/North American, have implemented a series of measures to curb the spread of the Covid-19 virus. As of April 2020, about 3.9 billion people in more than 90 countries in Asia, Europe, and North America were under some form of centralized governmental control such as compulsory confinement, curfew, lockdown, travel restriction, and quarantine (Sandford, 2020). It was the degree of compliance with the measures that made the difference. Second, since Covid-19 vaccines were first developed and rolled out in Western countries, there is no reason to believe that Asian countries have better government-managed public health systems.

[24]Several hypotheses have been proposed to explain these differences, such as population age (Landoni et al., 2021), the previous SARS experience (Küpper et al., 2020), genetics (Gupta and Misra, 2020; Klang et al., 2020; Krams et al., 2021), diet (Fonseca et al., 2020), and climate (Ma et al., 2020b; Oliveiros et al., 2020), to name a few. Although these arguments may be a good starting point for thinking further about the underlying mechanisms behind the differences between the two regions, to our knowledge, they are not convincing enough to elucidate this matter.

[25]If our previous hypotheses are correct, then we may also expect to see differential patterns within Asia. West Asia is not well suited to rice cultivation. In Appendix Figure B.1, for Asian countries located to the east of Pakistan (23.6 percent), Iran (15.3 percent), Tajikistan (15.0 percent), and Afghanistan (13.4 percent) are three exceptional countries in which rice constitutes more than 10 percent of agricultural production. Most countries in West Asia do not produce rice at all. Hence, rice farming Asian countries and non-rice farming Asian countries may show differential patterns in Covid-19 deaths and cases. In this vein, we define rice farming Asian countries as those in which the share of rice among staple crops is greater than or equal to 23.6 percent (Pakistan's share) and non-rice farming Asian countries as those where the share

Figure 2: The East-West Divide in Covid Deaths and Cases



(a) Covid Deaths as of Aug 31, 2021

(b) Covid Cases as of Aug 31, 2021

Notes: The figures summarize the aggregate Covid-19 deaths and cases (%) in Asia and the Western (Europe and North America) as of August 31, 2021. Following the Standard Country or Area Codes for Statistical Use (UN M49), Asia is reported separately for five distinct areas (West Asia, South Asia, Central Asia, Southeast Asia, and East Asia). Western region is also reported separately for five distinct areas (Northern America, Northern Europe, Southern Europe, Western Europe, and Eastern Europe). The data come from the World Health Organization (WHO) Covid-19 Detailed Surveillance Database.

Two issues naturally arise regarding our two key hypotheses above: (i) the observed differences between the two regions (see Figure 2) do not necessarily mean that Asian rice farming descendants are more committed to authority and more willing to monitor their neighbors in commons situations; (ii) even if we show that those Asian rice farming descendants are indeed more committed and vigilant, cross-country analyses suffer inherently from many confounding issues because countries' characteristics can be mixed. Those two issues challenge our ability to test our first hypothesis, that Asian rice farming traditions are effective in managing the pandemic. In the following sections, we overcome these issues by focusing on the unique history of Asian immigration to the US over the past six decades as a natural experiment (i.e., solving the second issue); and by leveraging a novel combination of four highly disaggregated data sources (i.e., solving the first issue).

of rice among staple crops is less than 23.6 percent. In Appendix Figure C.1, the confirmed Covid cases are shown by subregion as of Aug. 31, 2021. In rice farming Asian countries, the percentage of confirmed deaths and cases is 0.02% and 1.2%, respectively. In non-rice farming Asian countries, the percentage of confirmed deaths and cases are 0.06% and 4.5%, respectively.

4 Asian Immigrants and Rice Farming Traditions in the US

4.1 Asian Immigration History in the US as a Natural Experiment

Asian immigration history in the US provides us with a unique setting in which to test our hypotheses. First, because mass immigration from Asia began less than 60 years ago, Asian immigrants are more likely to retain the cultural traits and traditions of their countries of origin. The Immigration and Nationality Act of 1965 abolished the National Origins Formula, which had been the basis of a US immigration policy that restricted immigration from Asia, Southern Europe, and Eastern Europe. Since the passage of the Immigration and Nationality Act, the Asian migrant population has soared and is now the nation's fastest-growing racial or ethnic group.[26] This is in stark contrast to the immigration history of Europeans and Africans to the US, which began as early as the sixteenth century. European and African descendants are therefore less likely to retain the cultural traits and traditions of their ancestors.

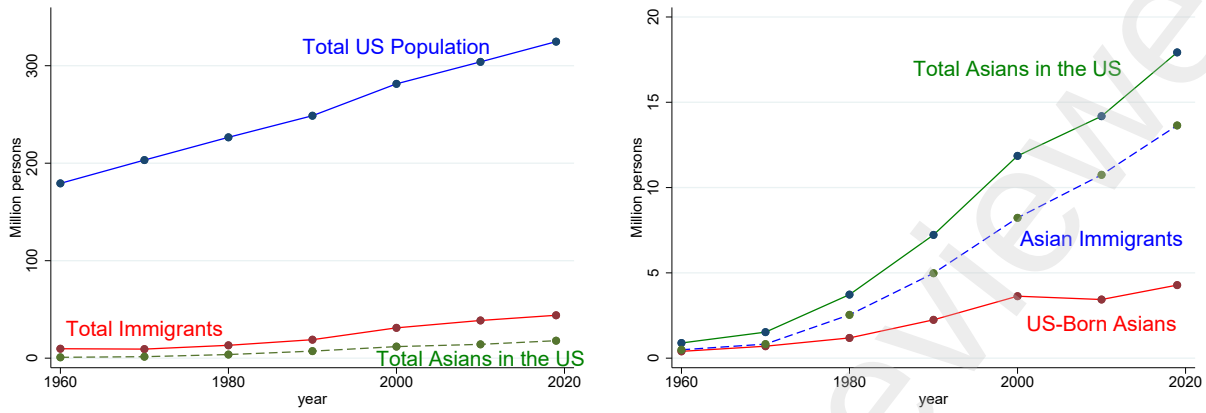
Second, Asians in the US are indeed good proxies for descendants of Asian rice farmers. One notable pattern of Asian immigration to the US is that the vast majority are from rice farming countries.[27] According to the US Census ACS data, of 13.6 million foreign-born Asian migrants in 2019, 11.8 million (86.8 percent) came from rice farming countries; 1.8 million (13.2 percent) came from non-rice farming countries.[28]

[26] Panel (a) of Figure 3 shows that the number of immigrants in the US increased from 9.7 million (5.4% of the US population) in 1960 to 44.0 million (13.6% of the US population) in 2019. Notably, Panel (b) of Figure 3 shows that the number of Asian immigrants grew from 0.9 million (0.5% of the US population) in 1960 to 17.9 million (5.5% of US population) in 2019. Here, Asian immigrants refers to both Asian immigrants from Asian countries and Asians who were born in the US. Asian migrants from Asia increased from 0.5 million in 1960 to 13.6 million in 2019; US-born Asians increased from and 0.4 million in 1960 to 4.3 million in 2019 (see Panel (b) of Figure 3). According to the 2017 US Census National Population Projection, by 2060, Asian immigrants will make up the largest immigrant group, surpassing 46 million and by 2065 will make up 38% of the foreign-born population and 14% of the US population (Passel and Rohal, 2015). The US Census 2017, US Census National Population Projection: https://www.census.gov/data/tables/2017/demo/popproj/2017-summary-tables.html

[27] Note again that we define rice farming Asian countries as those where the share of rice among staple crops is greater than or equal to 23.6 percent (Pakistan's share) and non-rice farming Asian countries as those where the share of rice among staple crops is less than 23.6 percent.

[28] Admittedly, it would be ideal to focus our study on the immigrants from rice farming countries only. Unfortunately, some datasets do not report the race of individuals at the country-of-origin level, but they do report race at a more aggregated level: Asian, White, Black, and Hispanic. Nevertheless, we believe that since about 90 percent of Asians in the US come from Asian rice farming countries that number is enough to test our hypotheses. In some datasets, the country of origin of individuals is identified. In such cases, we divide Asians into two groups, rice farming descendants and non-rice farming descendants.

Figure 3: Immigrants in the US, 1960 - 2020



(a) Total Population and Immigrants in the US

(b) Asian Immigrants in the US

Notes: Immigrants are defined as the foreign-born population in the US. US-Born Asians are defined as the Asian population whose places of the birth is recorded as the US. Data come from the historical census statistics on the foreign-born population of the US between 1960 and 2000 (Gibson and Jung, 2005) and the US Census American Community Survey for 2010 and 2020.

4.2 Retaining Asian Rice Farming Legacies of Asian Immigrants

A potential remaining threat to our identification strategy is assimilation of Asian immigrants. Although large-scale Asian immigration history began less than 60 years ago, we cannot leverage Asian immigration history to test our hypothesis if today those Asian rice farming descendants were fully assimilated into the US. Although this concern makes sense to a certain extent, we believe that Asian rice farming descendants have retained their ancestors' traits for the following reasons.

Racial and immigrant separation has long characterized cities and neighborhoods in the US, and the spatial separation of Asian migrants in the US can be understood in the broad background of US history. First, Asian migrants in the US have tended to settle in certain areas and cluster within their own communities. In 2019, the metropolitan areas with the largest number of Asian immigrants were New York, Los Angeles, and San Francisco. These three metro areas accounted for about 31% of the Asian population.[29] Using the 2020 Census Redistricting Data from the US Census Bureau, we calculate the weighted average of the Asian share in each neighborhood (census tract) to gauge the extent of clustering. Although Asians constitute only 5.9 percent of the US population the

[29] Among the 17.9 million Asians in the US in 2019, 2.2 million (12.1%) reside in New York, 2.1 million (11.8%) in Los Angeles, and 1.2 million (6.8%) in San Francisco.

average Asian person lives in a neighborhood that is 22.9 percent Asian.[30]

To further document the pattern of spatial separation of Asians in the US, using the US Census tract data, we use an index of dissimilarity (Massey and Denton, 1988; Massey et al., 2009; Fogli and Guerrieri, 2019) that measures the extent to which different groups (e.g., White/Black, White/Asian, and White/Hispanic) are distributed evenly over a set of geographical units. The calculation ranges from 0 (complete integration) to 100 (complete segregation), and identifies the percentage of one group that would have to move to a different neighborhood to eliminate segregation.[31] We find that the dissimilarity index for Asians is 49.9, implying that roughly 50 percent of Asians would have to move to a different neighborhood (census tract), to achieve an even distribution between Whites and Asians (See Table 2). Residential separation between Asians and Whites (49.9) is not as high as that between Blacks and Whites (58.9) in the US; the dissimilarity index is slightly higher for Asians than for Hispanics and Whites (47.3).

Table 2: Dissimilarity Index Relative to Whites by Race in the US

Race:	Asian	Black	Hispanic
	(1)	(2)	(3)
Dissimilarity Index	49.9	58.9	47.3

Notes: The reference group is Whites. The number of census tracts is 83,848. The number of states is 50, plus Washington, D.C. The dissimilarity indices are weighted by each state's total population.

Our finding of spatial separation of Asians in the US is consistent with findings in the demography literature. After 1970, when the largest immigrant groups hailed from Asian countries, a plurality of metropolitan areas saw increases in Asian residential segregation (Frey and Farley, 1996; White et al., 2003; Cutler et al., 2008). Using the 2000 Decennial Census and 2006-2010 ACS, Hall et al. (2019) found that minority groups still occupy

[30] We further calculate those numbers for Blacks and Hispanics. Blacks constitute 12.1 percent of the population and the average Black person lives in a neighborhood that is 40.4 percent Black; Hispanics constitute 18.7 percent of the population and the average Hispanic person lives in a neighborhood that is 43.7 percent Hispanic.

[31] The dissimilarity index is defined as follows:

$$\text{Dissimilarity Index}(j) = \frac{1}{2}\sum_i \left| \frac{x_i(j)}{X(j)} - \frac{y_i(j)}{Y(j)} \right| \tag{1}$$

where i refers to census tract and j means state. $X(j)$ and $Y(j)$ denote the total number of, respectively, Asian persons and White persons in state j. $x_i(j)$ and $y_i(j)$ denote the number of, respectively, Asian persons and White persons in census tract i in region j. We calculate the dissimilarity index in equation (1) by three race groups (i.e., Asian, Black, and Hispanic) relative to White. We measure the dissimilarity index for all 50 US states, plus Washington, D.C., and average at the national level using state-level population weights.

different social spaces than Whites.[32] Ethnic and immigrant residential segregation has also been investigated extensively by economists. Most document that cities that received more minorities lost a greater number of White residents (Card et al., 2008; Boustan, 2010; Saiz and Wachter, 2011; Cascio and Lewis, 2012).

In addition to the spatial separation of Asians, it is also well documented that Asian immigrants in the US strive to maintain their own cultural traits and traditions (Triandis, 1990; Kibria, 1994; Whyte, 1998; Coon and Kemmelmeier, 2001; Poudel-Tandukar et al., 2019; Ma et al., 2020a). Examples include within-group marriage, speaking their native language at home (Bisin et al., 2004; Giuliano and Nunn, 2021), and son preference (Almond and Edlund, 2008; Abrevaya, 2009; Almond et al., 2013; Blau et al., 2020).

A more recent study by Giuliano and Nunn (2021) supports this observation. They find empirically that when the environment is more stable across generations, culture is more likely to be persistent across generations. We relate their climate instability measure to the share of rice among staple crops at the country level and find that the correlation coefficient is -0.35. This means that rice farming regions have highly stable environments, which exhibit greater cultural persistence across generations.

In sum, we believe that because Asian rice farming descendants have formed their own communities they are thus are more likely to retain their cultural traits in the US. Therefore, instead of comparing people across countries, we can test our key hypotheses by comparing people and/or neighborhoods in the US, which enables us to control for confounding country characteristics. Henceforth use the US as our test bed.

5 Data

Our analysis leverages a novel combination of four primary data sources. First, we measure the degree to which public health in the pandemic (i.e., a common good) was managed differently by Asian rice farming descendants and others in the US. Using the Covid-19 Case Surveillance Restricted Access Detailed data from the Centers for Disease Control and Prevention (CDC), we measure patient-level Covid-19 exposure history–e.g., Covid cases and death–using demographic and geographic information in the US.

Next, we test whether appropriation and provision problems (i.e., common good problems) have been better resolved by Asian rice farming descendants than by others. The common good problems in the pandemic include vaccination, mask wearing, and social

[32] Hall et al. (2019) point out that workplace racial segregation is much lower than residential racial segregation in the US. This underscores that while legal protections in employment may have been successful, integration in residential space may have been difficult.

distancing. Thus we measure behavioral responses, as well as beliefs and norms, across Asian rice farming descendants and others, which capture credible commitment and mutual monitoring in commons situations in the US. More specifically, we use (i) Delphi's Covid-19 Trends and Impact Survey (CTIS) data from Facebook, (ii) US Census Household Pulse Survey (HPS) data, and (iii) Covid-19 Community Mobility Reports database from Google, adding to the CDC restricted data. We describe our variables construction procedure in this section and summarize the key variables in Appendix Table D.1.

5.1 CDC Data

To test whether public health in the pandemic was managed differently by Asian rice farming descendants and others in the US, we first measure the share of Asian rice farming descendants who were infected with (or died of) the Covid at the US county level, using the de-identified, patient-level data for each case from the Centers for Disease Control and Prevention (CDC), called Covid-19 Case Surveillance Restricted Access Detailed Data.[33] These data are particularly advantageous for our research. The publicly available CDC data do not provide county of residency information, but the restricted CDC data set contains both race and county of residence at the case level, which allows us to measure county-level Covid-19 cases (and deaths) by race. Together with county-level population by race data from the US Census ACS, we can test whether Asian rice farming descendants outperformed others in managing Covid-19 cases/deaths within narrowly defined geographical units (i.e., US counties).

The data are collected at the patient level by the US public health authorities.[34] The full dataset, as of Aug 30, 2021, covers 29,851,450 cases and 526,177 deaths.[35] The dataset contains 32 variables for all Covid-19 cases shared with CDC, including demographics, geography, exposure history, disease severity indicators and outcomes, and presence of any underlying medical conditions and risk behaviors.

Our data construction process is as follows. We imposed two major sample restrictions for our analysis. First, we dropped observations with a missing county FIPS code.[36]

[33] This "scientific use" dataset is designed with 32 fields, and stringent privacy protections, to provide more detailed information for researchers. We were granted access to the restricted data contingent upon compliance with the data use agreement. Another dataset, "Covid-19 Case Surveillance Public Use Data," is designed with 12 data fields and is accessible at http://data.CDC.gov.

[34] The data cover all U.S. states and autonomous reporting entities, including New York City, the District of Columbia, and U.S. territories and affiliates.

[35] CDC case counts and death counts include both confirmed and probable cases and deaths.

[36] 404,397 case counts were dropped (i.e., 1.4 percent of total cases); 3,168 death counts were dropped (i.e., 0.6 percent of total deaths).

Second, we dropped observations for which race was unidentifiable.[37] After the cleaning procedures, we have 18,868,810 Covid cases and 430,780 Covid deaths for which we can identify both race and county of residence.[38] For each county, we measure the Asian share of Covid cases/deaths in the total population of the county. In addition to these two core variables, we measure Covid case share and vaccination share as of Aug. 30, 2021, in each county from the Covid-19 Case Surveillance Public Use Data and each county's population information from the US Census American Community Survey (ACS). Panel A in Appendix Table D.1 presents descriptive statistics for the data.

5.2 Facebook Survey Data

To test whether commons problems in pandemics, such as vaccination, mask wearing, and social distancing, are better resolved by Asian rice farming descendants, we measure behavioral responses to the pandemic in the US. To achieve this goal, we use de-identified individual survey data, called Covid-19 Trends and Impact Survey (CTIS), from Facebook and the Delphi group at Carnegie Mellon University.[39] Since early April 2020, these survey data have been continuously collected, with about 50,000 US users participating per day.[40] The survey is offered to a random sample, stratified by geographic region, of about 100 million US residents from the Facebook Active User Base.[41] Participants are recruited for the surveys through an advertisement placed in their Facebook news feed. Users who click on the ad are taken to a survey.

The de-identified individual survey dataset has some advantages for investigating our research question. First, while the publicly available data provide aggregated averages

[37] Unidentified race information is defined as "Missing", "NA", or "Unknown". 10,578,234 case counts were dropped (i.e., 35.9 percent of remaining total cases); 92,229 deaths counts were dropped (i.e., 17.6 percent of remaining total death counts). Unfortunately, we lose sizable portion of observations especially in the second procedure. If those unidentified races happened to be biased toward Asians, then this may yield an issue of measurement error. Nevertheless, to our knowledge, there would be no definite reasons for this to be the case.

[38] For Covid cases, we have 2,881 unique county observations; for Covid deaths, we have 2,396 unique county observations. There are seven race categories: 1) White, Non-Hispanic, 2) Hispanic/Latino, 3) Black, Non-Hispanic, 4) Multiple/Other, Non-Hispanic, 5) Asian, Non-Hispanic, 6) American Indian/Alaska Native, Non-Hispanic, and 7) Native Hawaiian/Other Pacific Islander, Non-Hispanic.

[39] Delphi releases aggregate data publicly only. The de-identified individual dataset is made available to us by the official data use agreement. In compliance with the agreement, we maintain the confidentiality of individual survey responses. Note also that Facebook refers its users to the survey, but it does not receive any individual survey data.

[40] See more details at the following link: https://delphi.cmu.edu/covidcast/surveys/

[41] The sample is not drawn from the entire United States population. To account for the differences between Facebook users and the United States population, Carnegie Mellon University returns the unique IDs to Facebook, which creates weights that account for the sampling design and non-responses; these weights are then post-stratified to match the US general population by age, gender, and state (Barkay et al., 2020).

for counties and other geographic areas with a subset of survey questions, our confidential dataset contains information from individual survey responses as well as individual-level variables. These data allow us to capture a unique set of behavior responses – beliefs and norms regarding the public health in the pandemic – as well as demographic information all at the individual level. Specifically, our measures include social distancing, vaccination intention, and mask wearing, as well as beliefs/norms about these variables. Thus we can test whether Asian rice farming descendants better resolved the commons problems than others after controlling for potentially confounding individual characteristics.

We construct our data as follows. We use data from January 2021 to October 2021, which spans Wave 7, Wave 8, Wave 10, and Wave 11.[42] From the raw datasets, we use individual-level variables such as gender, age, county of residency, race, education, and work status.[43] Most important, we use Covid-related questions about travel, social distancing, mask wearing, and vaccination. Please refer to Appendix Table E.1.CTIS Variables Description for more details. The number of observations is 9,892,638. Then we restrict our sample to those with non-missing gender, age, county of residency, race, education, and work status; 2,162,126 responses were dropped (i.e., 21.9 percent of total responses). After this procedure, we have 7,730,512 responses. Panel B in Table D.1 presents descriptive statistics for the data.

5.3 US Census Survey Data

In addition, we use the US Census Household Pulse Survey (HPS) dataset to complement the Facebook Survey Data. The US Census HPS is a nationally representative survey designed to study how the pandemic affects households across the US from a social and economic perspective. Although the HPS has fewer observations than the Facebook survey, the HPS has some advantages: (i) the Census Bureau and its federal statistical partners are considered the leading and most reliable source of the nation's most important

[42] Beginning April 6, 2020, the Covid-19 Trends and Impacts Survey (CTIS) has been deployed in several waves. Respondents' race information is available to us only from January 2021. Hence, we focus on the survey results from Wave 7 and thereafter, which began on January 12, 2021. Note also that Wave 9 was skipped to synchronize the numbering with the international survey administered by the University of Maryland.

[43] Age is divided into seven categories: 1) 18-24, 2) 25-34, 3) 35-44, 4) 45-54, 5) 55-64, 6) 65-74, and 7) 75 and older. There are seven race categories: 1) White, Non-Hispanic, 2) Hispanic/Latino, 3) Black, Non-Hispanic, 4) Multiple/Other, Non-Hispanic, 5) Asian, Non-Hispanic, 6) American Indian/Alaska Native, Non-Hispanic, and 7) Native Hawaiian/Other Pacific Islander, Non-Hispanic. Education is divided into eight categories: 1) Less than high school, 2) High school graduate or equivalent, 3) Some college, 4) 2-year degree, 5) 4-year degree, 6) Master's degree, 7) Professional degree (e.g. MD, JD, DVM), and 8) Doctorate.

benchmark surveys; (ii) the HPS is nationally representative whereas the coverage of the Facebook data is limited to Facebook users. The two datasets provide complementary evidence on whether Asian rice farming descendants in the US managed the commons better than others in the pandemic. Since April 23, 2020, the HPS data have been collected in three phases (two weeks per round).[44] We use the HPS data from week 22 (January 6–18. 2021) to week 39 (September 29–October 11, 2021).[45] From the dataset, we use individual-level variables such as gender, age, state of residence, race, education, income, number of households, marital status, and health insurance status.[46] Most important, we collect answers to Covid-related questions about vaccination and social distancing. Please refer to Appendix Table E.2 HPS Variables Description for more details. The number of observations is 1,267,603. Panel C in Table D.1 presents descriptive statistics for the data.

5.4 Google Mobility Data

To overcome any potential measurement errors from the survey datasets, we measure county-level social distancing using Google's Covid-19 Community Mobility Reports. The key strength of the Google mobility dataset is that we can avoid response bias wherein people may feel pressure to give answers that are socially acceptable. Because the Google mobility data are collected from users' mobile devices by region and across different categories of places, the mobility data are relatively free from potential response bias, unlike survey data.[47]

The Google mobility data include daily time spent in workplaces, residential areas,

[44]Data collection for Phase 1 of the Household Pulse Survey began on April 23, 2020 and ended on July 21, 2020; for Phase 2 of the Household Pulse Survey began on August 19, 2020 and ended October 26, 2020; for Phase 3 of the Household Pulse Survey began on October 28, 2020 and ended March 29, 2021; for Phase 3.1 of the Household Pulse Survey began on April 14, 2021 and ended on July 5, 2021; for Phase 3.2 of the Household Pulse Survey began July 21, 2021 and ended on October 11, 2021. Data collection for Phase 3.3 of the Household Pulse Survey started on December 1, 2021 and is scheduled to continue until February 7, 2022.

[45]Two vaccination related questions are available from Week 22. Four social distancing questions are available from Week 34. Our dataset includes Phase 3, Phase 3.1, and Phase 3.2 of the Household Purse Survey.

[46]There are five race categories: 1) White, Alone, 2) Hispanic/Latino/Spanish, 3) Black, Alone, 4) Asian, Alone, and 5) Any other race alone, or race in combination. Education is defined as seven categories: 1) Less than high school, 2) Some high school, 3) High school graduate or equivalent (for example GED), 4) Some college, but degree not received or is in progress, 5)Associate's degree (for example AA, AS), 6) Bachelor's degree (for example BA, BS, AB), and 7) Graduate degree (for example master's, professional, doctorate). Income is defined as total household income (before taxes) in 2019 and eight categories: 1) Less than $25,000, 2) $25,000 - $34,999, 3) $35,000 - $49,999, 4) $50,000 - $74,999, 5) $75,000 - $99,999, 6) $100,000 - $149,999, 7) $150,000 - $199,999, and 8) $200,000 and above.

[47]No personally identifiable information, such as an individual's location, contacts, or movements, was made available at any point. The Google mobility data provide aggregated anonymous mobility information from users' mobile-device-location histories.

retail and recreational locations, and transit stations.[48] The data are tracked daily and in a consistent manner across US counties. More specifically, the daily data measure how visitors to (or time spent in) categorized places change in contrast to the baseline days, where the baseline days refer to the median value from the 5-week period Jan 3–Feb 6, 2020 (i.e., pre-Covid). For our analysis, we use two measures, workplace mobility and residential mobility, to gauge county-level social distancing. For each measure, we calculate the daily average percentage change (from 2020-02-15 to 2021-09-13) in mobility in the county (relative to the pre-Covid period, during the 5-week period Jan 3-Feb 6, 2020). The number of observations of workplace mobility (resp. residential mobility) is 2,794 (resp. 1,787). Panel D in Table D.1 presents descriptive statistics for the data. Please refer to Appendix F. Other Variables Construction for more details on other county-level control variables.

6 The Commons and Asian Rice Farming Descendants

Recall that our two key hypotheses are: (i) that Asian rice farming descendants outperformed in managing public health amid the pandemic (i.e., the commons); (ii) that unique traditions of Asian rice farming descendants contributed to resolving appropriation and provision problems (e.g., individual freedom in social distancing and in mask wearing; free-riding on vaccinations) in the pandemic.

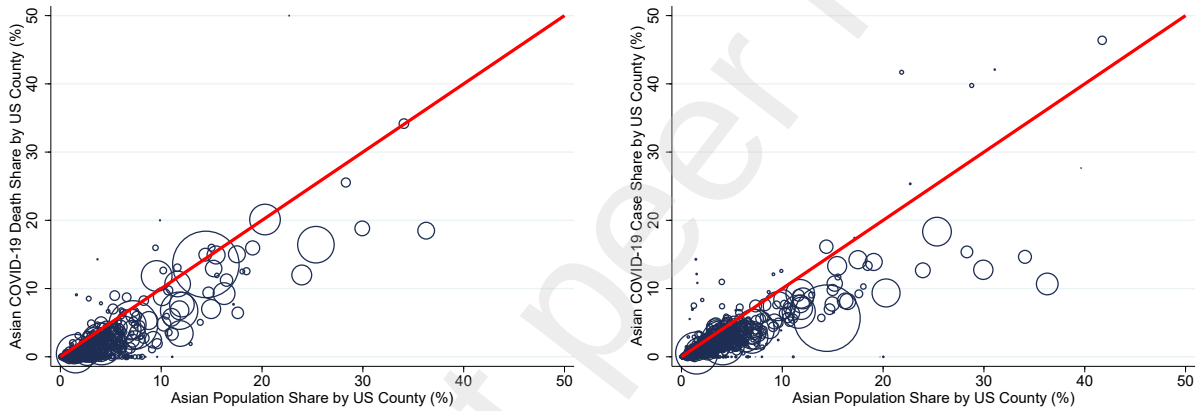
In this section, we test our first hypothesis: Asian rice farming descendants are less likely to contract and/or die from Covid. In section 6.1, using the patient-level CDC data, we first test whether Asians in the US are less likely to be infected by and to die from Covid-19. This allows us to assess whether the East-West divide in the pandemic (Sachs, 2020), as shown in section 3.3, is still valid within the US territory, which shares a central government. In section 6.2, using the county-level CDC data, we further provide a robustness check to confirm that Asian rice farming descendants, more specifically, outperformed in managing public health; we conduct a placebo test and find that Asian non-rice farming descendants do not show differential patterns.

[48] In Google's Covid-19 Community Mobility Reports, *Workplaces* refers places of work and office areas; *Residential Areas* refers places of residence and housing areas; *Retail & Recreation* refers places including restaurants, cafes, shopping centers, theme parks, museums, libraries, and movie theaters; and *Transit Stations* refers places including public transport hubs such as subway, bus, and train stations. For additional information about data collection, please refer to the following link: https://www.google.com/covid19/mobility.

6.1 Covid Deaths and Cases by Race across US Counties

We first examine whether Asians are less likely to contract or die of Covid across US counties. To do so, we calculate the share of the Asian population in each county. Next we calculate the share of Asian Covid cases and deaths in each county.[49] Then we draw a scatter plot to see the relationship between the two along a 45- degree line. If race is not a determinant of Covid cases and deaths, then we would expect each point (i.e., each county) to be located closely around on the 45-degree line. Figure 4 shows clearly that Asians are less likely to get and die from Covid even within narrowly defined geographic areas (i.e., US counties).[50]

Figure 4: Asian Covid Deaths and Cases across US counties



(a) Covid Deaths (N=2,396 counties) (b) Covid Cases (N=2,881 counties)

Notes: Asian denotes (Non-Hispanic) Asian. The red straight line is a 45 degree line (i.e. $y = x$). Each circle corresponds to US county. The observations are weighted by the total number of Covid deaths (and cases) in each county. The number of observations in each panel does not match with the number of total counties in the US. In the CDC restricted dataset, race and county information are missing for some observations. We keep observations that have race and county information. Hence, for some counties, we do not have Covid deaths in panel (a) and Covid cases in panel (b).

In order to formally test the hypothesis that Asians are less likely to contract and/or

[49]51Asian population data come from American Community Survey 2015-2019; Asian Covid deaths and cases data come from the Centers for Disease Control and Prevention (CDC). To match those two datasets, we use "(Non-Hispanic) Asian" category to denote Asians. It would be ideal to focus on rice farming Asian descendants only because some west Asian countries do not share rice cultures. Unfortunately, the CDC Covid data do not report race at the country level. Nevertheless, 86.8% of Asian immigrants are originated from rice farming countries in the US in 2019. Hence, we think that Asians would still be a good proxy to capture the Asian rice farming descendants in the US.

[50]In Appendix Figure G.1, we repeat the analyses using White and Black as control groups and find that those groups' Covid death and case shares are more or less proportional to their population shares across US counties.

die from Covid, we set up the following regression specification without a constant and test the null hypothesis of $H_0 : \beta = 1$.

$$\text{Asian Covid Share}_c = \beta \text{Asian Population Share}_c + \varepsilon_c \quad \text{(without a constant)} \qquad (2)$$

where c denotes county, Asian Covid Share$_c$ refers to the share of Asian Covid deaths and cases, separately, in county c. We further estimate equation (2) for White and Black groups.

Table 3: Covid Deaths and Cases by Race

Dependent Variable:	Covid Deaths Share			Covid Cases Share		
Race:	Asian	White	Black	Asian	White	Black
Null Hypothesis:			$H_0 : \beta = 1$			
	(1)	(2)	(3)	(4)	(5)	(6)
Population share	0.7066***	0.9990	1.1026***	0.5493***	0.9973	0.9535
(p-value)	(0.0000)	(0.7954)	(0.0000)	(0.0000)	(0.6171)	(0.8528)
Observations	2,396	2,396	2,396	2,881	2,881	2,881
R-squared	0.8994	0.9950	0.9594	0.8717	0.9962	0.9535

Notes: Asian denotes (Non-Hispanic) Asian. White denotes (Non-Hispanic) White and Hispanic. Black denotes (Non-Hispanic) Black. Observations are weighted by county's total Covid deaths and cases. Statistical tests are based on the null hypothesis of $H_0 : \beta = 1$ in equation (2). Robust standard errors are used. *** p<0.01, ** p<0.05, * p<0.1.

Table 3 presents the estimation results. . In Column (1), we start by relating the Asian Covid death share to the Asian population share. The coefficient is 0.7066 and is statistically significant at the 1 percent level. This result means that Asians are 29 percent less likely than non-Asians to die of Covid. In Columns (2) and (3), we repeat the analysis for Whites and Blacks. For Whites, the coefficient is 0.9990 and the p-value is 0.7954, meaning that the White population is not more or less likely to die of Covid. For Blacks, the coefficient is 1.1026 and statistically significant at the 1 percent level, implying that Blacks are 10 percent more likely than non-Blacks to die from Covid. In Column (4), we regress the share of Asian Covid cases on the share of the Asian population without a constant. The coefficient is 0.5493 and is statistically significant at the 1 percent level. Asians are 45 percent less likely than non-Asians to contract Covid. In Columns (5) and (6), we do not find any detectable patterns between race and Covid cases for Whites and Blacks, respectively.

Building on the estimates from Table 3, we further perform counterfactual analysis –Covid deaths and cases if the total rates of Covid deaths and cases had been the same as those of Asians in the US. Our core results show that, as of August 30, 2021, 183,013

American lives would have been saved and that 17,154,891 US residents would not have contracted Covid in the counterfactual scenario.[51]

6.2 Robustness Check and Placebo Test

Although our estimation in section 6.1 relies on a good proxy for Asian rice farming descendants (i.e., in 2019, 86.8% of Asian immigrants to the US originated in Asian rice farming countries), one may still worry about the accuracy of some measurements. Hence, we check whether the same results hold when we exclude non-rice farming descendants of Asians. Even though the CDC patient-level dataset is not disaggregated at the country-of-origin level, we can measure the share of *Asian rice farming immigrants* in each US county using the American Community Survey 2015-2019. Using this county-level accounting of the composition of Asian rice farming descendants in the US, we posit that a larger share of rice farming descendants is negatively correlated with cases of Covid across US counties. Figure 5 depicts the negative association. The slope of the linearly fitted red line is -0.235. Quantitatively, a 10 percentage point increase in the share of Asian rice farming descendants is associated with a 2.35 percentage point drop in Covid cases in the population.

Although the previous scatter plot shows a negative relation between Covid cases and the share of Asian rice farming descendants, there could be many other potentially confounding variables. To alleviate this concern, we estimate the following regression model:

$$\mathrm{Y}_c = \alpha + \beta \text{Asian Rice Farming Share}_c + \gamma X_c + \text{FEs} + \varepsilon_c \tag{3}$$

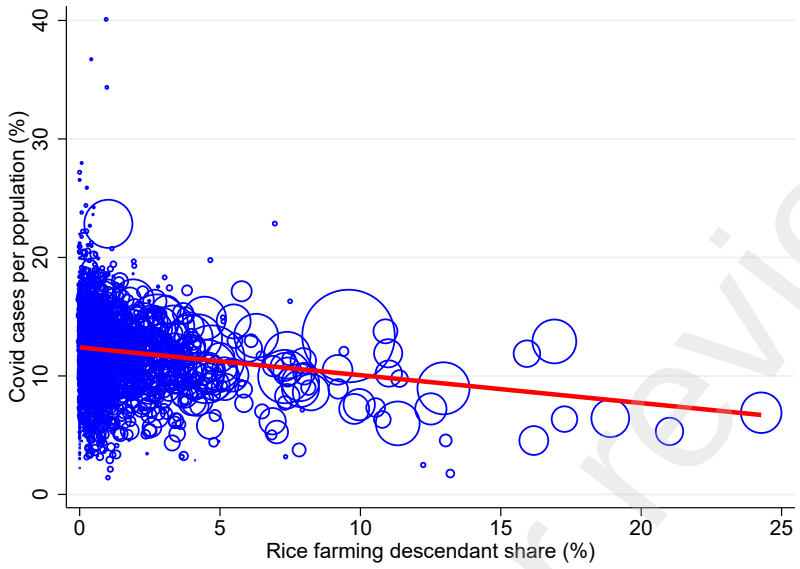
where c denotes county, Y_c denotes Covid cases per population in county c, X_c is a set of county-level control variables, and FEs are state fixed effects. Standard errors are clustered at the state level.

The control variables can alleviate concern that Asian rice farming descendants have different characteristics that may simultaneously affect the prevalence of Covid and the prevalence of residents descended from Asian rice farmers. Most important, the state fixed effects can control for any observable and unobservable state characteristics. X_c includes the (log) population density, (log) mean household annual income, the share with a college education or more, Republican vote share in 2016, and household size.

We find that the results in Section 6.1 are still robust to the different measure of rice farming descendants (and the different estimation approach). Panel A of Table 4 presents the estimation results. We start by relating the shares of Covid cases to rice farming

[51] Please refer to Appendix H. Counterfactual Analysis for more details.

Figure 5: Covid Cases and Asian Rice Farming Descendants



Notes: N=3,112 counties. Each circle corresponds to a US county. The observations are weighted by the total population in each county.

Table 4: Robustness Check and Placebo Test

Panel A. Robustness Check	Dep. Var.: Covid Cases Per Population			
	(1)	(2)	(3)	(4)
Asian Rice Farming Descendant Share	-0.2351***	-0.1754***	-0.2193***	-0.1594***
	(0.0562)	(0.0602)	(0.0669)	(0.0338)
Observations	3,112	3,111	3,112	3,111
R-squared	0.0988	0.4907	0.3432	0.6619
Panel B. Placebo Test	Dep. Var.: Covid Cases Per Population			
	(1)	(2)	(3)	(4)
Asian Non Rice Farming Descendant Share	-0.5299**	0.0115	-0.3361	0.0146
	(0.2498)	(0.2921)	(0.2982)	(0.2560)
Observations	3,112	3,111	3,112	3,111
R-squared	0.0178	0.4592	0.3068	0.6476
Control Variables	No	No	Yes	Yes
State FEs	No	Yes	No	Yes

Notes: Observations are weighted by a county's total population in the year 2019. Washington, D.C., has no counties. Hence, when we add state fixed effects, we lose one observation. Control variables include log population density, log mean household income, college or more, Republican vote share in 2016, household size (owner), and household size (renter). Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

descendants in the population without any control variables in column (1), by adding state fixed effects in column (2), by adding county-level control variables such as population density, mean household income, college or more share, Republican vote share, and household size, and by adding both the state fixed effects and the control variables in column (4). In our benchmark specification, i.e., column (4), the main coefficient of our interest is negative and is statistically significant at the 1 percent level. Quantitatively, a 10 percentage point increase in the share of Asian rice farming descendants is associated with a 1.59 percentage point decrease in Covid cases in the population.

We further conduct a placebo test to investigate the relationship between the share of Asian non- rice farming descendants and Covid cases across US counties because some Asian countries do not cultivate rice (e.g., West Asia). We consider Asian non-rice farming descendants as a "placebo" group, and we would expect to see no distinguishable effect in this case. Hence, we repeat the analysis in Panel A of Table 4 using the share of Asian non-rice farming descendants in lieu of Asian rice farming descendants. Panel B of Table 4 shows the estimation results. Consistent with our conjecture, we do not find any significant relationship between the share of Asian non-rice farming descendants and Covid cases across US counties.

Collectively, our findings establish that Asian rice farming descendants outperformed in managing public health amid the pandemic (i.e., the commons) based on a cross- country analysis of the East-West divide in Covid (Figure 2 of Section 3.3) and even in the US (the empirical findings in this Section). That is, we provide new evidence that Covid's East-West divide is not attributable to outside forces such as the "Leviathan."

7 Resolving Commons Problems in the Pandemic

We now test the second hypothesis, that Asian rice farming traditions are instrumental in resolving commons problems in the pandemic. As discussed in Section 2, since the Neolithic Revolution, Asian rice farmers have strived to solve two fundamental problems in common goods situations: appropriation and provision problems (Ostrom, 1990). They have developed unique institutions, through credible commitment, mutual monitoring, and subsequent sanctions, to avoid the tragedy of the commons in farming rice. Those institutions have shaped distinct Asian rice farming traits: strong commitment to a set of rules and monitoring their neighbors in common goods situations for fear of social rejection if they do not.

In Section 7.1, we first test whether Asian rice farming descendants resolved *provision problems* better than other populations. Developing herd immunity through vaccination

in society is a case in point.[52] We posit that Asian rice farming descendants are more willing to commit themselves to achieving herd immunity using their own resources to get vaccinated, instead of free-riding on others who are already immune. In Section 7.2, we then investigate whether Asian farming descendants better resolved *appropriation problems* than others. Mask wearing and social distancing are two examples of appropriation problems, which arise in pandemics when public health becomes scarce.[53] A pandemic, unlike normal times, provides us with a unique opportunity to test the differential behavioral responses to appropriation problems. We posit that Asian rice farming descendants are more likely to follow government mandates and monitor their neighbors' behaviors because they fear sanctions (ostracism) if they do not.[54]

7.1 Provision Problems and Asian Rice Farming Descendants

7.1.1 Vaccination

To study the provision problem in the pandemic, we first test whether Asian rice farming descendants are more willing to use their own resources to achieve herd immunity. We use the Covid-19 Trends and Impact Survey (CTIS) and the US Census Household Pulse Survey (HPS), which include vaccine intention questions along with race information at the individual level. Using these two surveys, we set up the following regression:

$$\mathrm{Y}_i = \alpha + \beta \mathrm{Asian}_i + \gamma X_i + \mathrm{FEs} + \varepsilon_i \tag{4}$$

where i denotes individual. In the CTIS, the question asks, "If a vaccine to prevent Covid-19 were offered to you today, would you choose to get vaccinated?"; and in the HPS, the question asks, "Once a vaccine to prevent Covid-19 is available to you, would you..."[55] For a dependent variable, we define Vaccine Intention$_i$ as an indicator variable that equals one if an individual i answers "Yes, definitely" in the CTIS and "Definitely get a vaccine" in the HPS. Asian$_i$ is an indicator variable that equals one if an individual is Asian.[56] X_i is a set of individual-level control variables, which include age, gender, and education

[52]Note that vaccination is a *provision problem*, which also exists in normal times (see Table 1). Herd immunity is in parallel with developing and maintaining irrigation systems in rice farming.

[53]Mask wearing and social distancing are equivalent to water usage during drought.

[54]In Asian rice farming areas, mutual monitoring and fear of ostracism are key mechanisms that have influenced human behavior exerted strong social control.

[55]There are four choices in the CTIS: 1) Yes, definitely, 2) Yes, probably, 3) No, probably not, and 4) No, definitely not. In the HPS, there are also four possible answers to the question: 1) Definitely get a vaccine, 2) Probably get a vaccine, 3) Probably NOT get a vaccine, and 4) Definitely NOT get a vaccine.

[56]It would be ideal to focus on rice farming Asian descendants only. However, the restricted CTIS and the HPS data do report race (e.g., Asian) but do not report ethnicity (e.g., Chinese).

for both surveys, work status for the CTIS, and the number of households, income, marital status, and health insurance status for the HPS. Those control variables can alleviate concerns that Asians may have different characteristics that simultaneously affect the intention to get vaccines. FEs are wave and county (or state) fixed effects in the CTIS (in the HPS). Standard errors are clustered at the county (or state) level.

Table 5 presents the estimation results. In Panel A., the CTIS results are presented; in Panel B., the HPS results are presented.[57] The CTIS covers from January 2021 to October 2021 (wave 7 through wave 11). The HPS runs from week 22 (i.e., January 6 - January 18, 2021) to week 39 (i.e., September 29 - October 11, 2021).[58] In both cases, we stack all observations and estimate equation (4) using a linear probability model with wave fixed effects. In both panels, we start by relating "Definitely get a vaccine" and the Asian dummy without any control variables. We sequentially add region FEs, individual- level control variables, and both, respectively, from columns (2) through (4). Across all columns in both panels, we found positive coefficients with statistical significance at the 1 percent level. In column (4), the most preferred specifications, the coefficient is 0.0670 in the CTIS and 0.0898 in the HPS. This means that Asians are 6.70 to 8.98 percentage points more likely to intend to get a vaccine than non-Asians in the US.

Perception of neighbors' resource provision to construct/maintain the commons is another measure of credible commitment (Ostrom, 1990). Using the Covid-19 Trends and Impact Survey (CTIS), we test whether Asian rice farming descendants are more likely to believe their neighbors will get vaccinated as a way of developing herd immunity. In the CTIS, there is a vaccine norm question that asks, "Thinking about your friends and family, how many have gotten a Covid-19 vaccine?"[59] We define Vaccine Norm$_i$ as an indicator variable that equals one if an individual i answers "All of the people" and 0 otherwise. Using the Vaccine Norm$_i$ variable as a dependent variable, we estimate equation (4).

In Table 6, we start by relating "How Many Have Gotten a Covid-19 Vaccine" to the Asian dummy without any control variables. Then we sequentially add county FEs, individual-level control variables, and both, respectively, in columns (2) through (4).

[57]Note that, in both datasets, samples are restricted to individuals who have not already received the Covid vaccine.

[58]In week 22, Covid vaccines had just started to roll out. According to CDC data, only 1.6 percent of the total US population had received at least one dose of the vaccine on January 6, 2021. Hence, the majority of those who were surveyed had not yet been vaccinated. The number of observations is 60,500 persons. In week 36, according to the CDC data, 63.8 percent of the total US population had received at least one dose; 54.5 percent were fully vaccinated on September 15, 2021. As the vaccination rates ramped up, the number of survey respondents who had not been vaccinated decreased. The number of observations is 7,955 persons.

[59]There are five choices: 1) All of the people, 2) Most people, 3) Some people, 4) A few people, and 5) None of the people.

Table 5: Vaccine Intention and Asians

Dependent Variable:	Vaccine Intention			
	(1)	(2)	(3)	(4)
Panel A.	Covid-19 Trends and Impact Survey (CTIS)			
Sample Period:	January - October, 2021			
Asian	0.1571***	0.0849***	0.1234***	0.0670***
	(0.0046)	(0.0054)	(0.0041)	(0.0054)
Observations	2,628,425	2,628,400	2,628,425	2,628,400
R-squared	0.1503	0.1858	0.1878	0.2164
Panel B.	US Census Household Pulse Survey (HPS)			
Sample Period:	January 6 - October 11, 2021			
Asian	0.1282***	0.1029***	0.1072***	0.0898***
	(0.0092)	(0.0087)	(0.0087)	(0.0095)
Observations	375,598	375,598	362,907	362,907
R-squared	0.1251	0.1449	0.1971	0.2093
Control Variables	No	No	Yes	Yes
Region FEs	No	Yes	No	Yes
Wave FEs	Yes	Yes	Yes	Yes

Notes: In both panels, we use a linear probability model; samples are restricted to individuals who had not already received the Covid vaccine. Hence, the number of observations denotes the number of unvaccinated people who responded to the survey question. In Panel A., control variables include Age, Gender, Education, and Work Status. In Panel B., control variables include Age, # in HH, Gender, Education, Income, Marital Status, and Health Insurance. Region refers to county in Panel A and state in Panel B. Standard errors are clustered at the county level in Panel A and at the state level in Panel B. *** p<0.01, ** p<0.05, * p<0.1.

Across all columns in both panels, we found positive coefficients with statistical significance at the 1 percent level. In column (4), the most preferred specification, we find that Asians are 10.23 percentage points more likely than non-Asians to think that all of their neighbors have been vaccinated. Our results imply that Asian rice farming descendants tend to believe their neighbors have a credible commitment to the commons in their society.

Having seen that Asians are more willing to be vaccinated and are more likely to believe that their neighbors have been vaccinated, we next ask whether Asian rice farming descendants *actually* received a vaccine at a higher rate than others. We use two datasets to test this hypothesis: (1) US Census Household Pulse Survey (HPS) and (2) CDC vaccination data.

The HPS asks the following question: "Have you received a Covid-19 vaccine?" We now estimate equation (4) with this new dependent variable. Table 7 shows the estima-

Table 6: Norms on Getting a Covid-19 Vaccine and How Asians Respond

Dependent Variable:	How Many Have Gotten a Covid-19 Vaccine			
Sample:	Covid-19 Trends and Impact Survey (CTIS)			
Sample Period:	March - October, 2021			
	(1)	(2)	(3)	(4)
Asian	0.1647***	0.1067***	0.1519***	0.1023***
	(0.0065)	(0.0038)	(0.0061)	(0.0037)
Control Variables	No	No	Yes	Yes
County FEs	No	Yes	No	Yes
Observations	1,686,155	1,686,120	1,686,155	1,686,120
R-squared	0.0039	0.0386	0.0336	0.0636

Notes: We use a linear probability model. We only have one wave (i.e., wave 11), and hence we do not need to control for wave FEs. Control variables include Age, Gender, Education, and Work Status. Standard errors are clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1.

tion results. Once again, we stack all observations. In Column (4) of Table 7, Asians received the Covid vaccine 5.61 percentage points more than non-Asians. As vaccine eligibility has changed over time, the estimated results using the combined surveys may be contaminated. Hence, we estimate equation (4) separately by survey wave. Figure 6 presents the estimated coefficients and their 95 percent confidence intervals are presented. Clearly, the coefficient become larger as time passes. The increasing coefficients suggest that once Covid vaccines are available to a broader population, Asians are more likely to be vaccinated. Our results are further supported by the county-level CDC vaccination data combined with the county-level share of Asian rice farming immigrants (see Appendix I for more details).

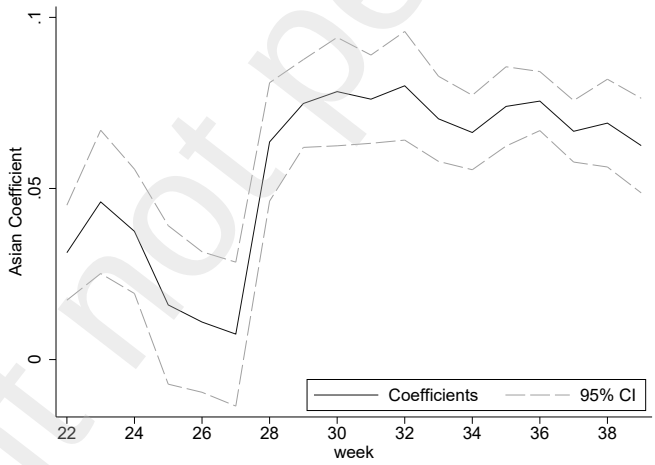
To sum up, Asian rice farming descendants are more likely to commit their own resources in the form of vaccination to achieve herd immunity in the common goods situation, thereby better resolving the provision problem. Using the county-level CDC dataset, we find that a higher vaccination rate is correlated with fewer Covid cases and deaths at the county level (see Appendix J), which also aligns well with the documented literature on vaccine effectiveness in preventing Covid-19 (Mulligan et al., 2020; Jackson et al., 2020; Sahin et al., 2020; Polack et al., 2020). We can conclude that because Asian rice farming descendants better resolved the provision problem in the pandemic, overexploitation of the commons could have been less severe.

Table 7: Vaccine Received and Asians

Dependent Variable:	Received Covid vaccine			
Sample:	US Census Household Pulse Survey (HPS)			
Sample Period:	January 6 - October 11, 2021			
	(1)	(2)	(3)	(4)
Asian	0.0439***	0.0439***	0.0635***	0.0561***
	(0.0047)	(0.0047)	(0.0040)	(0.0037)
Control Variables	No	No	Yes	Yes
State FEs	No	Yes	No	Yes
Wave FEs	Yes	Yes	Yes	Yes
Observations	1,257,147	1,257,147	1,241,566	1,241,566
R-squared	0.3431	0.3431	0.3947	0.3963

Notes: Samples are not restricted in this analysis. The number of observations denotes the number of people who responded to the survey question. We use a linear probability model. Control variables include Age, # of HH, Gender, Education, Income, Marital Status, and Health Insurance. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

Figure 6: Vaccinations of Asians over Time



Notes: We estimate equation (4) separately by survey wave. The dependent variable is an indicator variable of vaccine received. The x-axis represents the survey wave (or week). The coefficients along with 95% confidence intervals are presented.

7.2 Appropriation Problems and Asian Rice Farming Descendants

7.2.1 Mask Wearing

To study the appropriation problem in the pandemic, we focus on mask wearing and social distancing, issues that arise only in pandemics when public health becomes scarcer. First, we study mask wearing behavior. The Covid-19 Trends and Impact Survey (CTIS) includes mask-related questions as well as race information at the individual level. One question asks, "How effective is wearing a face mask for preventing the spread of Covid-19?"[60] We define Mask Wearing Norm$_i$ as an indicator variable that equals one if an individual i answers "Very effective" and 0 otherwise. Another survey question asks, "In the past 7 days, how often did you wear a mask when in public?"[61] We define Mask Wearing Behavior$_i$ as an indicator variable that equals one if an individual i answers "All the time" and 0 otherwise. Using Mask Wearing Norm$_i$ and Mask Wearing Behavior$_i$ variables as a dependent variable, we estimate equation (4).

In Panel A of Table 8, we start by relating "How Effective is Wearing a Face Mask" to the Asian dummy without any control variables. Then, we sequentially add county FEs, individual-level control variables, and both, respectively, from columns (2) through (4). Across all columns in both panels, we found positive coefficients with statistical significance at the 1 percent level. In column (4), the most preferred specification, we find that Asians are 13.97 percentage points more likely than non-Asians to think that wearing a face mask for preventing the spread of Covid-19 is very effective. In Panel B, we start by relating "Wear a Mask When in Public" to the Asian dummy without any control variables. Then we sequentially add county FEs, individual-level control variables, and both, respectively, from columns (2) through (4). Across all columns in both panels, we found positive coefficients with statistical significance at the 1 percent level. In column (4), the most preferred specification, we find that Asians in the US are 10.72 percentage points more likely than non-Asians to wear a mask all the time in public.

Collectively, Asian rice farming descendants possess traits that help control the appropriation problem in the pandemic. Because they fear being ostracized in mask-wearing situations, they are more likely to wear a mask, which hinders the spread of the virus, validating the second hypothesis. Recent research also corroborates our view that most masks reduce the probability of transmitting the Covid virus (Cheng et al., 2021).

[60] There are four choices: 1) Very effective, 2) Moderately effective, 3) Slightly effective, and 4) Not effective at all.

[61] There are six choices: 1) All the time, 2) Most of the time, 3) Some of the time, 4) A little of the time, 5) None of the time, and 6) I have not been in public during the past 7 days.

Table 8: Mask Wearing and Asians

Panel A.	Dep. Var.: How Effective Is Wearing a Face Mask			
Sample Period:	March - October, 2021			
	(1)	(2)	(3)	(4)
Asian	0.1974***	0.1178***	0.2125***	0.1397***
	(0.0049)	(0.0046)	(0.0045)	(0.0048)
Observations	1,684,575	1,684,542	1,684,575	1,684,542
R-squared	0.0033	0.0423	0.0413	0.0795
Panel B.	Dep. Var.: Wear a Mask When in Public			
Sample Period:	January - October, 2021			
	(1)	(2)	(3)	(4)
Asian	0.1406***	0.0758***	0.1720***	0.1072***
	(0.0059)	(0.0032)	(0.0054)	(0.0030)
Observations	7,484,477	7,484,464	7,484,477	7,484,464
R-squared	0.1678	0.2030	0.1972	0.2332
Control Variables	No	No	Yes	Yes
County FEs	No	Yes	No	Yes
Wave FEs	Yes	Yes	Yes	Yes

Notes: We use Covid-19 Trends and Impact Survey (CTIS). We use a linear probability model. Control variables include Age, Gender, Education, and Work Status. Standard errors are clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1.

7.2.2 Social Distancing from Survey Data

We now turn our attention to social distancing, another example of an appropriation problem. The CTIS asks about belief in social distancing and includes race information at the individual level. They survey asks, "How effective is social distancing for preventing the spread of Covid-19?"[62] We define Social Distancing Norm$_i$ as an indicator variable that equals one if an individual i answers "Very effective" and 0 otherwise. Using Social Distancing Norm$_i$ variable as a dependent variable, we estimate equation (4). Table 9 shows the estimation results. Across all columns, we found positive coefficients with statistical significance at the 1 percent level. In column (4), the most preferred specification, we find that Asians are 11.98 percentage points more likely than non-Asians to think that social distancing for preventing the spread of Covid-19 is very effective.[63]

We turn our attention to whether Asians *actually* changed their behaviors, not just

[62]There are four choices: 1) Very effective, 2) Moderately effective, 3) Slightly effective, and 4) Not effective at all.

[63]In Appendix K, using attitude-related questions from a database of travel-related behaviors and attitudes before, during, and after the Covid-19 in the US (henceforth, ASU survey), we find additional evidence that Asians are more likely to be agreeable to government mandates during the pandemic.

attitudes, or behaved differently than non-Asians in response to the pandemic. We use two survey datasets to test this question: (1) Covid-19 Trends and Impact Survey (CTIS) and (2) US Census Household Pulse Survey (HPS).

Table 9: Belief in Social Distancing and Asians

Dependent Variable:	How Effective Is Social Distancing			
Sample:	Covid-19 Trends and Impact Survey (CTIS)			
Sample Period:	March - October, 2021			
	(1)	(2)	(3)	(4)
Asian	0.1632***	0.1014***	0.1772***	0.1198***
	(0.0049)	(0.0047)	(0.0046)	(0.0049)
Control Variables	No	No	Yes	Yes
County FEs	No	Yes	No	Yes
Wave FEs	Yes	Yes	Yes	Yes
Observations	1,683,013	1,682,980	1,683,013	1,682,980
R-squared	0.0022	0.0255	0.0235	0.0462

Notes: We use a linear probability model. Control variables include Age, Gender, Education, and Work Status. Standard errors are clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Travel, Social Distancing, and Asians

Sample:	Covid-19 Trends and Impact Survey (CTIS)			
Sample Period:	January - October, 2021			
Panel A.	Dep. Var.: Travel Outside of Your State			
	(1)	(2)	(3)	(4)
Asian	-0.0296***	-0.0104***	-0.0530***	-0.0302***
	(0.0039)	(0.0017)	(0.0034)	(0.0016)
Observations	7,261,026	7,261,016	7,261,026	7,261,016
R-squared	0.0119	0.0527	0.0356	0.0766
Panel B.	Dep. Var.: Avoid Contact with Other People			
	(1)	(2)	(3)	(4)
Asian	0.0851***	0.0651***	0.1031***	0.0815***
	(0.0029)	(0.0044)	(0.0027)	(0.0036)
Observations	7,714,078	7,714,068	7,714,078	7,714,068
R-squared	0.0090	0.0217	0.0363	0.0465
Control Variables	No	No	Yes	Yes
County FEs	No	Yes	No	Yes
Wave FEs	Yes	Yes	Yes	Yes

Notes: We use a linear probability model. Control variables include Age, Gender, Education, and Work Status. Standard errors are clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1.

First, we use the CTIS, which includes questions about social distancing behavior. One question asks, "In the past 7 days, have you traveled outside of your state?" We define Travel outside$_i$ as an indicator variable that equals one if an individual i answers "Yes" and 0 otherwise. Another questions asks, "In the past 7 days, how often did you intentionally avoid contact with other people?"[64] We define Social distancing$_i$ as an indicator variable that equals one if an individual i answers "All the time" and 0 otherwise. Using these two variables, we estimate equation (4). Table 10 presents the estimation results. In Panel A., we use Travel outside$_i$ as a dependent variable; in Panel B., we use Social distancing$_i$ as a dependent variable. Across all columns in Panel A (respectively, in Panel B), we found negative (positive) coefficients with statistical significance at the 1 percent level. In our most preferred specification (column (4) in each panel), we find that Asians are 3.02 percentage points less likely to travel outside of their state, and that Asians are 8.15 percentage points more likely to avoid contact with other people all the time than non-Asians in the US.

Second, we use the HPS survey (July 21 - August 30, 2021, three waves from 34 to 36), which asks some behavior questions related to Covid. We estimate equation (4) with four different dependent variables as follows:
{Worked onsite$_i$, Telework$_i$, Shopping$_i$, Restaurants$_i$}. Worked onsite$_i$ refers to "In the last 7 days, have you or your household worked onsite at a workplace?" Telework$_i$ refers to "In the last 7 days, have you or your household teleworked or worked from home?" Shopping$_i$ refers to "In the last 7 days, have you or your household done in-store shopping?" Restaurants$_i$ refers to "In the last 7 days, have you or your household eaten indoors at restaurants?" Each dependent variable is an indicator variable that equals one if individual i answers "Yes." Table 11 presents the estimation results. Across all specifications, we add control variables, state fixed effects, and wave fixed effects. In Column (1), we find that Asians are 8.9 percentage points less likely to have worked onsite at a workplace. In Column (2), Asians are 2.2 percentage points more likely to have teleworked. In Column (3), the results reveal that Asians are 4.8 percentage points less likely to have done in-store shopping. In Column (4), we uncover that Asians are 3.5 percentage points less likely to have eaten indoors at restaurants. All in all, Asians not only are more likely to intend to implement social distancing, but also are actually less likely to move and/or travel, more likely to avoid contact with other people, and more likely to telework during the pandemic. All of these findings validate the second hypothesis.

[64] There are five choices: 1) All the time, 2) Most of the time, 3) Some of the time, 4) A little of the time, and 5) None of the time.

Table 11: Behaviors and Asians

Dependent Variable:	Worked onsite	Telework	Shopping	Restaurants
Sample:	US Census Household Pulse Survey (HPS)			
Sample Period:	July 21 - October 11, 2021			
	(1)	(2)	(3)	(4)
Asian	-0.0885***	0.0217**	-0.0484***	-0.0353***
	(0.0102)	(0.0090)	(0.0030)	(0.0117)
Control Variables	Yes	Yes	Yes	Yes
State FEs	Yes	Yes	Yes	Yes
Wave FEs	Yes	Yes	Yes	Yes
Observations	347,682	338,730	344,600	342,649
R-squared	0.2132	0.2318	0.0596	0.0567

Notes: We use a linear probability model. Control variables include Age, # of HH, Gender, Education, Income, Marital Status, and Health Insurance. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

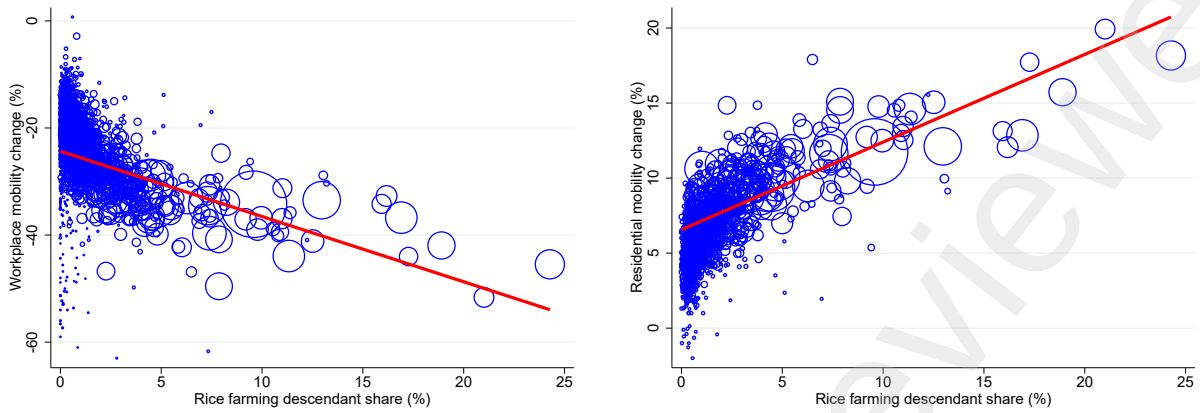
7.2.3 Social Distancing from Google Mobility Data

We now use Google's Covid-19 Community Mobility Report to investigate whether Asian rice farming descendants are more likely to engage in social distancing. As in Section 6.2, we leverage the county-level share of Asian rice farming immigrants in each US county. We use two measures: "Workplace Mobility" and "Residential Mobility." For each measure, we calculate the daily average percentage change (from Feb. 15, 2020 to Sept. 13, 2021) in mobility in the county (relative to the pre-Covid period, during the 5-week period Jan. 3 – Feb. 6, 2020). In Panel (a) of Figure 7, there is a negative correlation between workplace mobility and the share of Asian rice farming descendant at the county level. In Panel (b), there is a positive correlation between residential mobility and the share of Asian rice farming descendant at the county level.

We then estimate equation (3) with these two new dependent variables separately. Table 12 presents the estimation results. In column (4) of Panel A, a 10 percentage point increase in the share of rice farming descendants is associated with a 2.3 percentage point de- crease in workplace mobility. In column (4) of Panel B, a 10 percentage point increase in the share of rice farming descendants is associated with a 2.2 percentage point increase in residential mobility.

In sum, because Asian rice farming descendants are more likely to practice social distancing, they are less likely to contract and/or die from Covid. It has been well documented that population movement played a major role in the spread of Covid and that the social distancing intervention has been effective in curbing the spread of Covid (Lai

Figure 7: Community Mobility and Asian Rice Farming Descendants: Scatter Plots



(a) Workplace Mobility (N=2,794 counties) (b) Residential Mobility (N=1,787 counties)

Notes: Each circle corresponds to a US county. The observations are weighted by the total population in each county.

Table 12: Community Mobility and Asian Rice Farming Descendants: Regression Results

Panel A.	Dep. Var.: Workplace Mobility Change			
	(1)	(2)	(3)	(4)
Asian Rice Farming Descendant Share	-1.2197***	-1.2571***	-0.2643***	-0.2342***
	(0.1748)	(0.1887)	(0.0419)	(0.0362)
Observations	2,794	2,793	2,794	2,793
R-squared	0.4724	0.5881	0.8058	0.8478
Panel B.	Dep. Var.: Residential Mobility Change			
	(1)	(2)	(3)	(4)
Asian Rice Farming Descendant Share	0.5840***	0.6057***	0.1974***	0.2184***
	(0.0537)	(0.0564)	(0.0247)	(0.0232)
Observations	1,787	1,786	1,787	1,786
R-squared	0.6141	0.7251	0.8911	0.9253
Control Variables	No	No	Yes	Yes
State FEs	No	Yes	No	Yes

Notes: Observations are weighted by county's total population in year 2019. Washington, D.C., has no counties. Hence, when we add state fixed effects, we lose one observation. Control variables include log population density, log mean household income, college or more, republican vote share in 2016, household size (owner), and household size (renter). Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

et al., 2020; Wellenius et al., 2021; Kwon et al., 2021).[65]

[65] In Appendix J, using the county-level CDC dataset and Google's mobility data, we confirm that lower workplace mobility and higher residential mobility are associated with fewer Covid cases and deaths.

8 Conclusion

Public health in a pandemic is a common good. The Covid pandemic therefore naturally gave rise to common goods problems. From an economist's perspective, the reason Asian rice farming countries performed better than the US and Europe in the early phases of the pandemic boils down to the extent to which countries (or cultures) manage their commons.

Unraveling the cause of the differences may be of interest to academic researchers. More fundamentally, however, it is crucial to understand how the traditions of Asian rice farming countries could save human lives. As history repeats itself, it is expected that commons issues in public health will arise again in the future, not just confined to Covid-19. We believe that our novel conceptual framework can shed light on understanding the ongoing pandemic, which is no doubt a tragedy of the commons.

Why is this new perspective important? Because the issues related to the pandemic can clearly be identified as problems arising from the commons, we can turn to the solutions to commons problems in the literature. Ostrom (1990) pointed out that, historically, neither the state nor the market had been entirely successful in solving commons problems. Despite this view, she stressed that the "tragedy" in such situations isn't inevitable and observed that commons problems have often been solved by voluntary organizations rather than by a coercive state. Perhaps, in the era of Covid, human cooperation through credible commitment is what is needed to avoid future tragedies of the commons.

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Appendix

Appendix A: What is a Common Good?

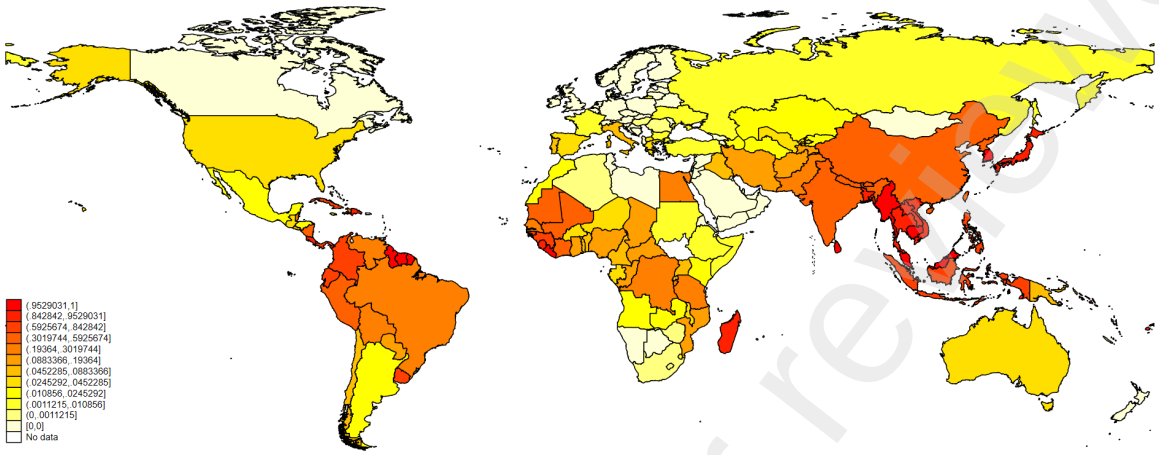
"Commons" are resources to which everyone has free access, such as fish stocks and minerals. If the supply of the commons is scarce, then common resources are subject to the tragedy of the commons. In the cases of fishing and mining, self-interested individuals act for their own benefit, overcatching and overextracting from the commons resources and depleting them for all. One might imagine that the tragedy of the commons is restricted to only a few fisheries and mining areas; however, it is applicable to a surprisingly diverse array of problems. Some examples are irrigation systems in drought, congested public roads, and clean air and water.

To be clear, in economics, common goods have two characteristics: they are nonexclusive and rival. In contrast, public goods are both nonexclusive and nonrival. A good is nonexclusive if people cannot be excluded from consuming it; a good is nonrival if the marginal cost of its provision to an additional consumer is zero. To better understand the difference, irrigation water in the rainy season can be nonrival (i.e., a public good), but irrigation water in a drought can be rival if water becomes scarce (i.e., a common good). The existence of scarcity is key to understanding the conceptual difference between public goods and common goods, as well as the issue of the tragedy of the commons.

To avoid a tragedy of the commons, a group (society, village, community, country, global institution) has to resolve two fundamental issues: the problems of appropriation and provision (Gardner et al., 1990). With respect to appropriation, as common goods are nonexclusive, too many individuals are allowed to appropriate from the resource, which leads to the depletion of the resource. In regard to provision, individuals are less likely to invest in resource itself through the construction and the maintenance of the system because of free-riding. It is worth noting that, in a public goods situation, provision problems exist but appropriation problem do not, because public goods are nonrival. Both types of problems are involved in every common goods situation to a greater or lesser degree, and successful institutions are the ones that resolve both types of problems (Ostrom, 1990).

Appendix B: The Geographical Distribution of Rice in 2000

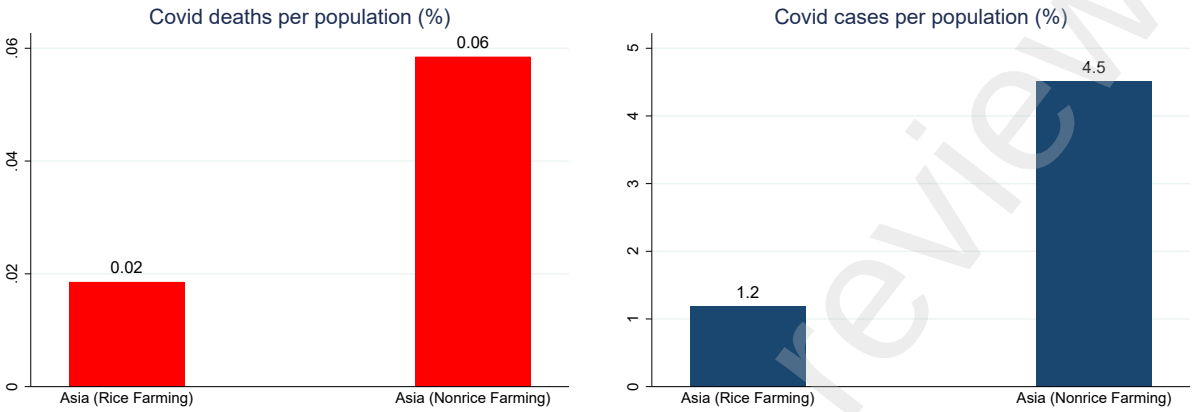
Figure B.1: The Share of Rice among Staple Crops (2000)



Notes: This figure reports the geographical distribution of rice production among staple crop (cereals) production in the year of 2000. The production data are sourced from Food and Agriculture Organization of the United Nations (FAO) FAOSTAT Database. We use the rice product code corresponding to "FAOSTAT 0027" (i.e., HS code 1006.10; SITC REV.2 code 042.1). Data on rice relate to crops harvested for dry grain only, excluding crops harvested for feeding animals.

Appendix C: Covid Deaths and Cases within Asia

Figure C.1: The Rice-Nonrice Divide within Asia in Covid Deaths and Cases



(a) Covid Deaths as of Aug 31, 2021

(b) Covid Cases as of Aug 31, 2021

Notes: We define rice farming countries as those where the share of rice among staple crops is greater than or equal to 23.6 percent (Pakistan's share). Rice farming countries include the following 20 countries among 46 Asian countries: Brunei, Burma, Cambodia, East Timor, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam in Southeast Asia; China, Japan, and South Korea in East Asia; Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka in South Asia. Nonrice farming countries include the following 26 countries among 46 Asian countries: Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan in Central Asia; Mongolia in East Asia; Afghanistan, Iran, and Maldives in South Asia; Armenia, Azerbaijan, Bahrain, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, UAE, and Yemen in West Asia.

Appendix D: Descriptive Statistics for the Main Variables

Table D.1: Descriptive Statistics

	Mean (1)	SD (2)	p1 (3)	p99 (4)	Observations (5)
Panel A. CDC Data					
Asian Share of Covid Deaths	3.62	5.12	0.00	20.12	2,396
Asian Share of Covid Cases	3.09	3.75	0.00	18.34	2,881
Covid Case Share	11.60	2.94	4.93	19.43	3,112
Vaccination Share	48.36	12.59	8.28	71.92	3,112
Panel B. Facebook Survey Data					
Travel Outside	0.12	0.32	0	1	7,261,026
Social Distance	0.15	0.36	0	1	7,714,078
Mask Wearing	0.58	0.49	0	1	7,484,477
Vaccine Intention	0.40	0.49	0	1	2,628,425
Belief on Social Distancing	0.50	0.50	0	1	1,683,013
Belief on Mask Wearing	0.54	0.50	0	1	1,684,575
Norm on Vaccine	0.18	0.38	0	1	1,686,155
Asian	0.02	0.15	0	1	7,730,512
Panel C. US Census Survey Data					
Vaccine Intention	0.52	0.50	0	1	375,598
Vaccine Received	0.67	0.47	0	1	1,257,147
Worked Onsite	0.55	0.50	0	1	347,682
Telework	0.37	0.48	0	1	338,730
Shopping	0.86	0.35	0	1	344,600
Restaurants	0.53	0.50	0	1	342,649
Age	53.69	15.86	21	85	1,267,603
Asian	0.05	0.22	0	1	1,267,603
Panel D. Google Mobility Data					
Workplace Mobility	-28.60	6.99	-46.74	-13.77	2,794
Residential Mobility	8.67	2.95	3.11	17.73	1,787

Notes: The table presents mean, standard deviation (SD), and the first (p1) and ninety-ninth (p99) percentiles of the main variables used in the empirical analysis. In Panel A., the observations of Asian shares of Covid deaths (and cases) are weighted by the total number of Covid deaths (and cases) in each county. In Panel A. for Covid case share and Vaccination share, the observations are weighted by county's total population in the year 2019. In Panel D. the observations are weighted by a county's total population in the year 2019.

Appendix E: Survey Variables Description

Table E.1: CTIS Variables Description

Variable	Survey Questionnaire & Choices
Travel Outside	In the past 7 days, have you traveled outside of your state? *(1) Yes*; (2) No
Social Distancing	In the past 7 days, how often did you intentionally avoid contact with other people? *(1) All of the time*; (2) Most of the time; (3) Some of the time; (4) A little of the time; (5) None of the time
Mask Wearing	In the past 7 days, how often did you wear a mask when in public? *(1) All of the time*; (2) Most of the time; (3) Some of the time; (4) A little of the time; (5) None of the time; (6) I have not been in public during the past 7 days
Vaccine Intention	If a vaccine to prevent Covid-19 were offered to you today, would you choose to get vaccinated? *(1) Yes, definitely*; (2) Yes, probably; (3) No, probably; (4) No, definitely not
Belief in Social Distancing	How effective is social distancing for preventing the spread of Covid-19? *(1) Very effective*; (2) Moderately effective; (3) Slightly effective; (4) Not effective at all
Belief in Mask Wearing	How effective is wearing a face mask for preventing the spread of Covid-19? *(1) Very effective*; (2) Moderately effective; (3) Slightly effective; (4) Not effective at all
Norm on Vaccine	Thinking about your friends and family, how many have gotten a Covid-19 vaccine? *(1) None of the people*; (2) A few people; (3) Some people; (4) Most people; (5) All of the people

Notes: In each case, we define a dummy variable that equals 1 if a respondent answers the italicized choice above and 0 otherwise. From Wave 7 to Wave 11, we use four questions: Travel Outside, Social Distancing, Mask Wearing, and Vaccination. In Wave 11, we use three additional Covid-related questions: Belief in Social Distancing, Belief in Mask Wearing, and Norm on Vaccine.

Table E.2: HPS Variables Description

Variable	Survey Questionnaire & Choices
Vaccine Intention	Have you received a Covid-19 vaccine? *(1) Yes*; (2) No
Vaccine Received	Once a vaccine to prevent Covid-19 is available to you, would you? *(1) Yes*; (2) No
Worked Onsite	In the last 7 days, have you or your household done any of the following… Worked onsite at a workplace? *(1) Yes*; (2) No
Telework	Teleworked or worked from home? *(1) Yes*; (2) No
Shopping	In-store shopping? *(1) Yes*; (2) No
Restaurants	Eating indoors at restaurants? *(1) Yes*; (2) No

Notes: In each case, we define a dummy variable that equals 1 if a respondent answers the italicized choice above and 0 otherwise. From week 22 to week 39, we use two vaccination-related questions: Vaccine Intention and Vaccine Received. From week 34 to week 39, we have four additional social distancing questions: Worked Onsite, Telework, Shopping, and Restaurants.

Appendix F: Other Variables Construction

We include a broad set of demographic and socioeconomic covariates. We construct county-level control variables from two sources. First, we use the American Community Survey (ACS) 5-year estimates from 2015 to 2019 to control for county-level demographic and economic confounding factors including population density, mean household income, college or more share, household size (owner), and household size (renter). Second, we include voting data on the US presidential election to uncouple the responses about Covid-19 from political ideology. Using data from David Leip's Election Atlas, we control for voting results at the county level in the 2016 US presidential election. The data include county-level votes for each candidate from the Republican and Democratic Parties as well as third-party candidates. We compute the vote share for the Republican candidates, which is defined as the number of Republican votes divided by the total votes for Republican and Democratic candidates. The following Table F.1 presents descriptive statistics of the county-level control variables.

Table F.1: Descriptive Statistics of Other Control Variables

	Mean	SD	p1	p99	Observations
	(1)	(2)	(3)	(4)	(5)
Asian rice farming share (2019)	3.48	3.93	0.04	18.90	3,112
Log of population density (2019)	5.32	1.69	1.15	9.58	3,112
Log of mean household income (2019)	11.36	0.25	10.83	12.01	3,112
College or more share (2019)	32.13	11.25	11.53	61.31	3,112
Republican vote share (2016)	48.53	18.12	9.85	84.90	3,112
Household size (owner) (2019)	2.65	0.26	2.16	3.39	3,112
Household size (renter) (2019)	2.73	0.27	2.19	3.40	3,112

Notes: The table presents mean, standard deviation (SD), and the first (p1) and ninety-ninth (p99) percentiles of the main variables used in the empirical analysis. Observations are weighted by total county population in the year 2019.

We also construct the share of rice farming descendants in the US at the county level using the ACS data. The dataset includes the country of birth for the foreign-born population at the county level.[66] We measure the number of Asian rice farming descendants at the county level by aggregating the foreign- born population whose places of birth are indicated as the following rice farming countries[67]: Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam, Brunei, East Timor in *Southeast Asia*;

[66]The foreign-born population is defined as anyone who is not a U.S. citizen at birth, including naturalized U.S. citizens, legal permanent residents, temporary visa migrants, humanitarian migrants, and unauthorized migrants.

[67]We define rice farming Asian countries as those with the share of rice among staple crops is greater than 23.6 percent (i.e., Pakistan's share) and nonrice farming Asian countries as those with the share of rice among staple crops is less than or equal to 23.6 percent.

China, Korea, Hong Kong, Japan, Taiwan, Macau in *East Asia*; Bangladesh, India, Nepal, Sri Lanka in *South-Central Asia*. It is noteworthy that the share of Asian rice farming descendants (Figure F.3 is negatively associated with Covid cases (Figure F.1) and positively associated with Covid vaccinations (Figure F.2).

Figure F.1: Covid Cases per Population (%)

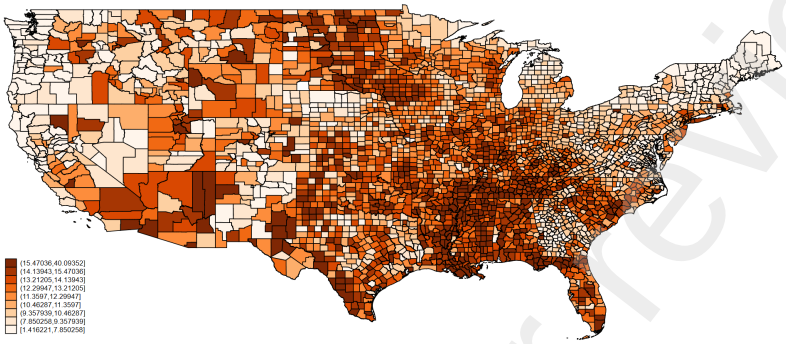


Figure F.2: Covid Vaccinations per Population (%)

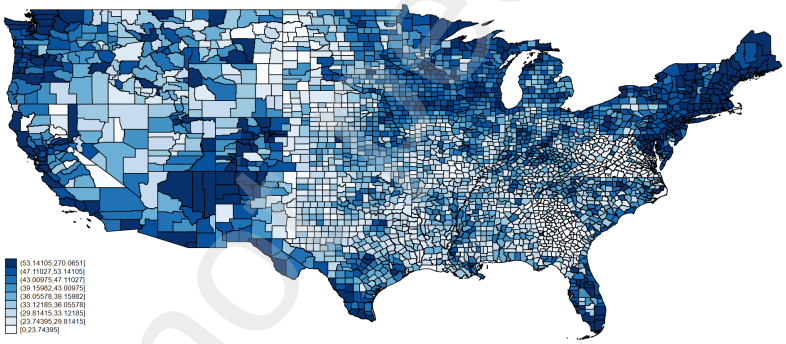
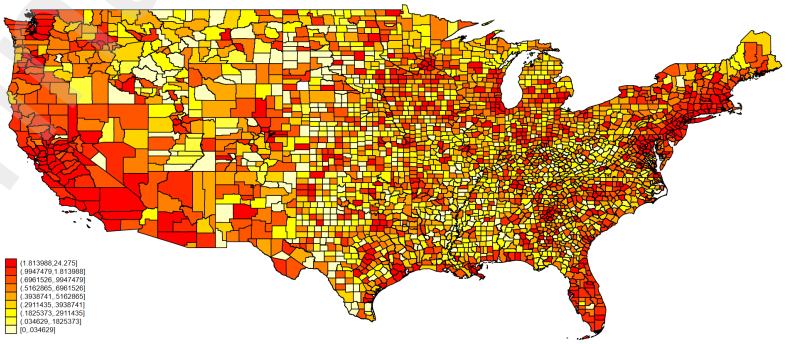
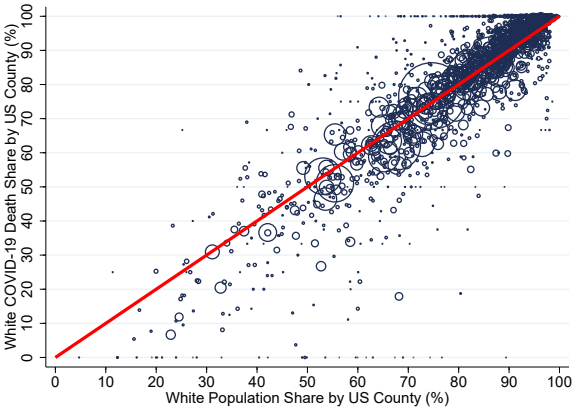


Figure F.3: Asian Rice Farming Descendants Share (%)

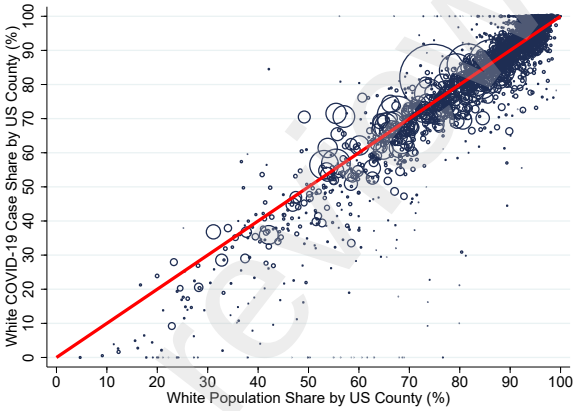


Appendix G: Covid Deaths and Cases across US counties

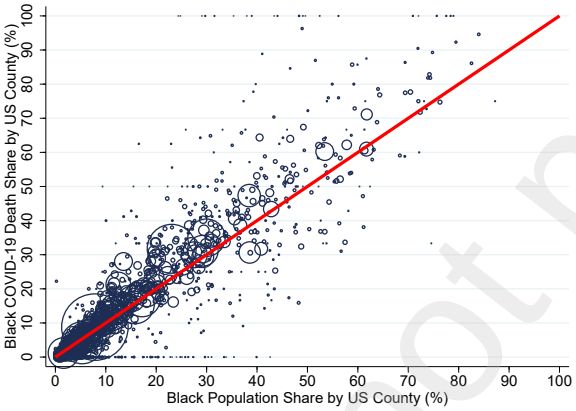
Figure G.1: White/Black Covid Deaths and Cases across US counties



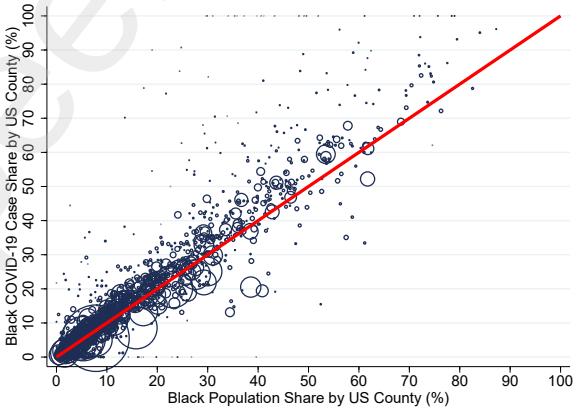
(a) White, Covid Deaths (N=2,396 counties)



(b) White, Covid Cases (N=2,881 counties)



(c) Black, Covid Deaths (N=2,396 counties)



(d) Black, Covid Cases (N=2,881 counties)

Notes: White denotes (Non-Hispanic) White and Hispanic. Black denotes (Non-Hispanic) Black. The straight red line is a 45-degree line (i.e. y = x). Each circle corresponds to a US county. The observations are weighted by the total number of Covid deaths (and cases) in each county. The number of observations in each panel does not match the number of total counties in the US. In the CDC restricted dataset, race and county information are missing for some observations. We keep observations that have race and county information. Hence, for some counties, we do not have Covid deaths in panel (a) and Covid cases in panel (b). After this cleaning procedure, we have a total of 2,396 counties in panel (a) and 2,881 counties in panel (b).

Appendix H: Counterfactual Analysis

To infer the total number of Covid deaths and cases among non-Asians and Asians, we use the coefficient of 0.7066 in column (1) and the coefficient of 0.5493 in column (4) of Table 3. Total counts in Panels B and C report the estimated numbers. Then we use the rates of Covid deaths and cases for Asians, 0.00136 and 0.064, respectively, to estimate the counterfactual Covid deaths and cases in the US. The observed numbers of Covid deaths and cases as of Aug. 30, 2021, were 623,752 and 38,059,649, respectively. If the rates of Covid deaths and cases had been the same as those for Asians in the US, the counterfactual Covid deaths and cases would have been 440,739 and 20,904,758, respectively.

Table H.1: Counterfactual Covid Deaths and Cases

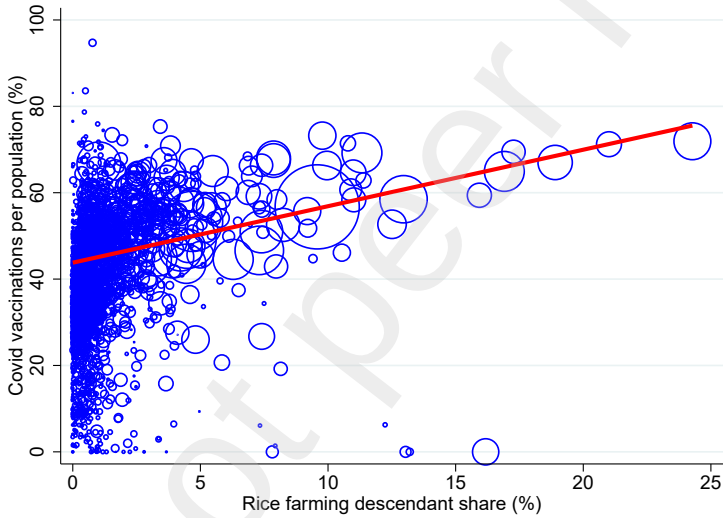
Race:	Total (1)	Non-Asian (2)	Asian (3)
Panel A. Population			
Total Count	324,697,795	306,773,586	17,924,209
Panel B. Covid Deaths			
Total Count	623,752	599,422	24,330
Deaths Rate	0.00192	0.00195	0.00136
Counterfactual Total Count	440,739	416,409	24,330
Counterfactual Deaths Rate	0.00136	0.00136	0.00136
Difference	183,013	183,013	0
Panel C. Covid Cases			
Total Count	38,059,649	36,905,649	1,154,000
Cases Rate	0.117	0.120	0.064
Counterfactual Total Count	20,904,758	19,750,758	1,154,000
Counterfactual Cases Rate	0.064	0.064	0.064
Difference	17,154,891	17,154,891	0

Notes: Asian denotes (Non-Hispanic) Asian.

Appendix I: Vaccinations and Asian Rice Farming Descendants

Using the CDC vaccination data at the county level, we explore whether Asian rice farming descendants in the US received a vaccine at a higher rate than others. As in Section 6.2, we leverage the county-level share of Asian rice farming immigrants in each US county to corroborate our hypothesis. Figure I.1 illustrates the positive association between Covid vaccinations and the share of Asian rice farming descendants at the county level. The slope of the linearly fitted red line is 1.308. Quantitatively, a 10 percentage point increase in the share of rice farming descendants is associated with a 13.1 percentage point increase in Covid vaccinations in the population.

Figure I.1: Vaccinations and Asian Rice Farming Descendants



Notes: N=3,112 counties. Each circle corresponds to a US county. The observations are weighted by the total population in each county.

Using Covid Vaccinations Per Population$_c$ variable as a dependent variable, we estimate equation (3). Table I.1 presents the estimation results. In Column (1), we start by relating the share of Covid vaccinations in the population and the share of Asian rice farming descendants without any control variables. In Columns (2) and (3), we add state fixed effects and county-level control variables, respectively, relative to the specification in Column (1). Last, in Column (4), our benchmark specification, we include both the state fixed effects and the control variables. The main coefficient of interest is 0.2795 and is statistically significant at the 5 percent level. Quantitatively, a 10 percentage point increase in the share of Asian rice farming descendants is associated with a 2.80 percentage point increase in Covid vaccinations in the population.

Table I.1: Vaccinations and Asian Rice Farming Descendants

Dependent Variable:	Covid Vaccinations Per Population			
Sample:	CDC Covid-19 Data			
	(1)	(2)	(3)	(4)
Asian Rice Farming Descendant Share	1.3068***	1.4908***	-0.2331	0.2795**
	(0.2328)	(0.1912)	(0.3435)	(0.1136)
Control Variables	No	No	Yes	Yes
State FEs	No	Yes	No	Yes
Observations	3,112	3,111	3,112	3,111
R-squared	0.1666	0.6600	0.4438	0.7940

Notes: Observations are weighted by county's total population in year 2019. Washington, D.C., has no counties. Hence, when we add state fixed effects, we lose one observation. Control variables include log population density, log mean household income, college or more, republican vote share in 2016, household size (owner), and household size (renter). Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix J: Covid, Vaccination, and Mobility

In Appendix Table J.1, using county-level CDC data, we regress Covid cases (and deaths) on Covid vaccinations at the county level with state fixed effects. In Columns (1) and (4), we find that a 10 percentage point increase in Covid vaccinations in the population is associated with a 0.438 (0.019) percentage point drop in Covid cases (Covid deaths).

In addition, using county-level CDC data combined with Google mobility data, we regress Covid cases (and deaths) against workplace mobility and residential mobility at the county level with state fixed effects. In Columns (2) and (5), we find that a 10 percentage point increase in workplace mobility is associated with a 0.703 (0.028) percentage point increase in Covid cases (Covid deaths). In Columns (3) and (6), we find that a 10 percentage point increase in residential mobility is associated with a 1.871 (0.066) percentage point decrease in Covid cases (Covid deaths). Hence, for Asian rice farming descendants in the US, higher vaccination rates, lower workplace mobility, and higher residential mobility translate into lower rates of Covid cases and deaths.

Table J.1: Covid, Vaccination, and Mobility

Dependent Variable:	Covid Cases			Covid Deaths		
	(1)	(2)	(3)	(4)	(5)	(6)
Covid Vaccination	-0.0438*			-0.0019***		
	(0.0251)			(0.0003)		
Workplace Mobility		0.0703**			0.0028**	
		(0.0262)			(0.0013)	
Residential Mobility			-0.1871*			-0.0066**
			(0.0953)			(0.0031)
State FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,110	2,793	1,786	3,110	2,793	1,786
R-squared	0.4769	0.4811	0.4928	0.3863	0.3892	0.4127

Notes: Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix K: Attitudes toward Social Distancing from ASU Survey

We posit that Asian rice farming descendants are more likely to commit themselves to various mandates and orders. In a database of travel-related behaviors and attitudes before, during, and after the Covid-19 in the US (i.e. ASU survey),[68] there are are four attitude-related questions at the individual level. Using this survey, we set up the following regression:

$$\mathrm{Y}_i = \alpha + \beta \mathrm{Asian}_i + \gamma X_i + \mathrm{FEs} + \varepsilon_i \tag{5}$$

where $\mathrm{Y}_i \in \{\mathrm{Stayhome}_i, \mathrm{Overreact}_i, \mathrm{Economic}_i, \mathrm{Norm}_i\}$ is an indicator variable that equals one if individual i strongly agrees on the question.[69]

$\mathrm{Stayhome}_i$ refers to "Everyone should just stay home as much as possible until the coronavirus has subsided." $\mathrm{Overreact}_i$ refers to "Society is overreacting to the coronavirus." $\mathrm{Economic}_i$ refers to "Shutting down businesses to prevent the spread of coronavirus is not worth the economic damage that will result." Norm_i refers to "My friends and family expect me to stay at home until the coronavirus subsides." Asian_i is an indicator variable that equals one if an individual is Asian.[70] X_i is a set of individual-level control variables, which include age, the number of households, gender, education, income, and survey wave dummy. Those control variables can alleviate concerns that Asians may have different characteristics that simultaneously affect the outcome variables. FEs are state fixed effects. Standard errors are clustered at the state level. We estimate equation (5) using a linear probability model.

Table K.1 presents the estimation results. Across all specifications, we add control variables and state fixed effects. In Column (1), we find that Asians are 4.0 percentage points more likely to strongly agree that everyone should stay home as much as possible until the coronavirus has subsided. In Column (2), the result shows that Asians are 4.2 percentage points less likely to strongly agree that society is overreacting to the coronavirus. In Column (3), the results reveal that Asians are 3.4 percentage points less likely to strongly agree that shutting down businesses to prevent the spread of coronavirus is

[68] The Covid Future Wave 1 Survey Data is a nationwide longitudinal survey collecting information about travel-related behaviors and attitudes before, during, and after the Covid-19 pandemic. The survey questions include commuting, daily travel, air travel, working from home, online learning, shopping, and risk perception, along with attitudinal, socioeconomic, and demographic information. The survey contains 8,723 responses that are publicly available. An early version of the survey was conducted from April to June 2020, when the stay-at-home orders were in place in most parts of the country, which is called Wave 1A (n=1,110). A slightly modified larger-scale survey, Wave 1B (n=7,613), was conducted between late June and October 2020. We use both Waves (i.e., 1A and 1B) in our analysis.

[69] There are five choices: 1) Strongly agree, 2) Somewhat agree, 3) Neutral, 4) Somewhat disagree, and 5) Strongly disagree.

[70] It would be ideal to focus on rice farming Asian descendants only. However, the ASU survey does not report ethnicity at the country level.

Table K.1: Attitudes and Asians

Dependent Variable:	Stayhome	Overreact	Economic	Norm
Sample:		ASU Survey		
	(1)	(2)	(3)	(4)
Asian	0.0398**	-0.0423***	-0.0336**	0.0824**
	(0.0170)	(0.0113)	(0.0134)	(0.0314)
Control Variables	Yes	Yes	Yes	Yes
State FEs	Yes	Yes	Yes	Yes
Observations	8,709	8,709	8,709	8,709
R-squared	0.0266	0.0295	0.0310	0.0529

Notes: We use a linear probability model. Control variables include Age, # of HH, Gender, Education, Income, and Survey Wave Dummy. Standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

not worth the economic damage that will result. In Column (4), we find that Asians are 8.2 percentage points more likely to strongly agree that their friends and family expect them to stay at home until the coronavirus subsides. Taken together, the attitude survey reveals that Asians are more likely to commit themselves to mandates and less likely to pursue individual freedom amid in a pandemic.