Traditional political institutions, cooperation, and the provisioning of public goods in Oaxaca, Mexico

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Abstract

The broad, cross-cultural variation in human cooperation is an evolutionary puzzle. Cultural evolution researchers have proposed that this variation can be traced to variation in social norms and institutions. However, the role of norms and institutions in human cooperation remains a topic of debate. Here, we leverage a unique natural laboratory to study the relationship between institutions and cooperation. In the highly culturally diverse state of Oaxaca, Mexico, there is broad variation in the traditional indigenous political institutions by which communities self-govern. Drawing on cultural evolutionary theory, we hypothesize that communities with institutions that (1) comprise more powerful norms about service to the community, (2) levy harsher sanctions against defectors, and (3) build more interdependence are better able to mobilize cooperation and provide public goods. To test this hypothesis, we apply an econometric approach to a combination of existing secondary data and newly quantified ethnographic data for 418 Oaxacan communities. Results reveal that communities with stronger institutions mobilize more cooperation for the group benefit, such as migrant remittances for public works projects. However, we find little evidence that this cooperation translates into tangible public goods outcomes, such as provisioning of piped

water. Nonetheless, this study provides support for the cultural evolutionary hypothesis that cooperation varies with institutions.

1. Introduction

Human groups face many cooperative challenges, such as managing common-pool resources, furnishing public goods, and defending the community against outside threats. Yet, we see broad, cross-cultural variation in the scale and context of human cooperation (Henrich & Muthukrishna, 2021; Henrich & Henrich, 2007). While some small-scale societies cooperate mainly within close kin groups (e.g the Machiguenga, Johnson, 2003), others effectively mobilize cooperation between hundreds of individuals in communal hunting, warfare, and infrastructure work (Boyd & Richerson, 2022; Mathew & Boyd, 2011). At the extreme end, people living in large-scale, WEIRD societies regularly cooperate with strangers whom they will never meet– adhering to traffic rules, paying taxes, and donating blood (Schulz et al., 2019). Because features of human-evolved psychology such as kin altruism and reciprocal altruism cannot account for this rich behavioral diversity, the cross-cultural variation in cooperation poses an evolutionary puzzle.

In a step towards solving this puzzle, cultural evolution researchers theorize that social norms and institutions shape cooperation. Social norms are culturally-transmitted rules about behavior that group members share and enforce, such as "drivers should obey the speed limit." Institutions are packages of norms that regulate behavior within different domains, such as kinship and religion. Cultural evolutionary theory suggests that human psychology coevolves with norms and institutions. At the proximate level, this theory posits that our minds adapt to the local institutional environment over the course of ontogeny (Henrich, 2020; Henrich & Muthukrishna, 2021). For example, a child in a society with kin-based institutions that venerate elders may grow

up to be more conformist and obedient than a child in a society with weak kin-based institutions that instead value individuality (Schulz et al., 2019). Theorists have proposed that this process is facilitated by genetically evolved capacities for dealing with social norms. This "norm psychology" promotes norm acquisition, transmission, and enforcement. Social norms can become internalized, transforming them from external rules to internal motivations, preferences, and heuristics (Chudek & Henrich, 2011). In addition, institutions can harness cooperation-stabilizing mechanisms such as punishment and reputation to motivate adherence to cooperative norms (Curtin et al., 2024; Henrich & Muthukrisha, 2021). Over larger time scales, as social norms and institutions culturally evolve, they pull psychology along, generating striking, non-genetic, cross-cultural variation (Henrich, 2020; Henrich & Muthukrishna, 2021).

A growing body of empirical evidence supports this cultural evolutionary view of human cooperation. For example, cross-cultural psychological research with children has revealed that the developmental trajectory of prosocial behavior is shaped by local social norms (House et al., 2013, 2020). Likewise, among adults, experiments using anonymous, one-shot behavioral economics games suggest a role for internalized norms in cooperation (Henrich et al., 2001, 2010; Henrich & Ensminger, 2014; Purzycki et al., 2016; Rustagi, 2023). Moreover, many different types of institutions have been shown to shape aspects of prosociality, including kin-based institutions (Akbari et al., 2019; Enke, 2019; Moscona et al., 2017; Schulz et al., 2019), mutual aid institutions (Cronk, Berbesque, et al., 2019; Curtin et al., 2024), common-pool resource institutions (Lansing, 1991; Ostrom, 1990), market institutions (Henrich et al., 2001, 2010; Rustagi, 2023; Rustagi et al., 2010), and religions (Norenzayan et al., 2016; Purzycki et al., 2016). Nonetheless, the role of norms and institutions in the evolution of human cooperation is still under debate (Kurzban et al., 2015; Lamba & Mace, 2011).

In this project, we leverage a unique natural laboratory to examine whether institutions shape cooperation within groups. Oaxaca, a mountainous state in southern Mexico, hosts immense cultural diversity. Sixteen main ethnolinguistic groups speaking over 100 distinct languages call Oaxaca home (Eberhard et al., 2019), and about 66% of the population self-identify as indigenous (Instituto Nacional de Estadística Geographía e Informatica, 2010, 2015) (Figure 1). With indigenous Oaxacans' identities strongly tied to their local community, many town-level microcultures thrive in the state (Dennis, 1987: 19; Nader, 1964). Speaking to this cultural fragmentation, Oaxaca contains roughly 23% of Mexico's municipalities, despite taking up merely 5% of the country by area. Municipalities in Mexico are second-level administrative divisions– just below the state– which directly receive federal funding. Many Oaxacan municipalities comprise a single community or one central community (*cabecera*) orbited by several outlying hamlets (*agencias*). This means that these small cultural units often serve as their own administrative unit. Oaxaca therefore presents a compelling setting for studying how cooperation relates to institutional variation.

Among Oaxaca's 570 municipalities, 418 are governed by traditional political institutions formally called *sistemas normativos indígenas* ("indigenous regulatory systems") and locally known as *usos y costumbres* ("customs and traditions") (Figure 1). Ushered into law by state constitutional reforms in the 1990s, this system grants municipalities the right to relative autonomy. Under this system, community function is structured by a mosaic of institutions related to communal decision-making, obligatory community service, communal control of resources, citizenship, and internal justice. For example, citizens must pass through the *cargo* system, which consists of a hierarchical

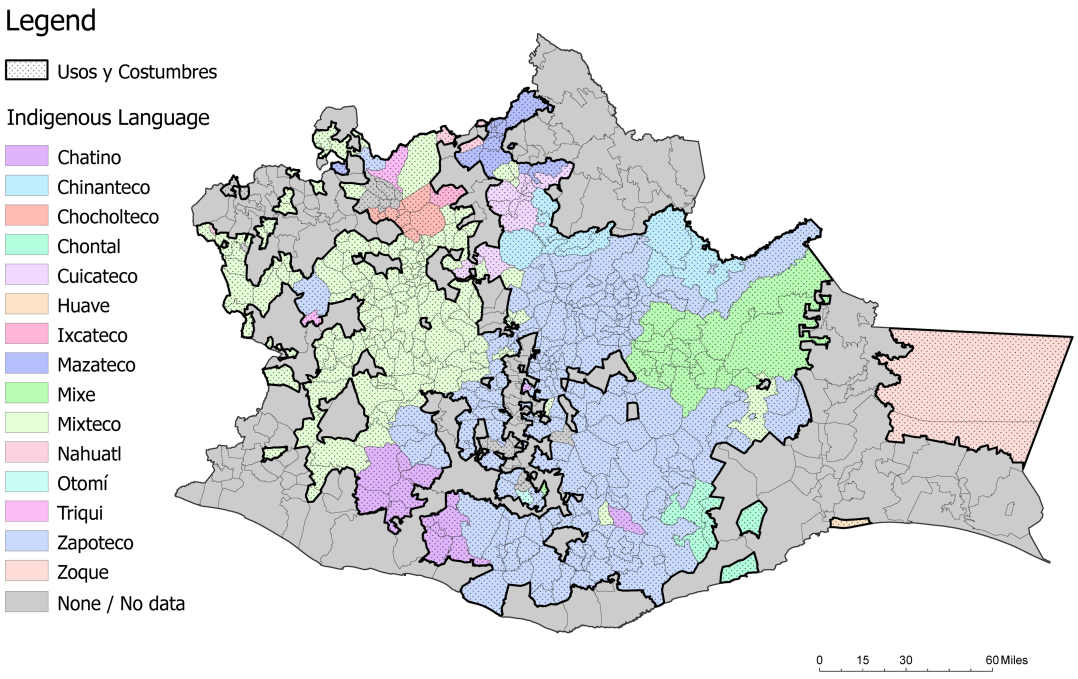

Figure 1. Indigenous languages spoken in Oaxaca's *usos y costumbres* municipalities. This map shows the municipalities of Oaxaca. Areas that are darkly outlined and dotted are run under *usos y costumbres*. These municipalities are colored according to the indigenous language spoken. There are 16 main language groups represented in Oaxaca, and over 100 distinct languages. Indigenous languages are spoken in some non-*usos y costumbres* municipalities, but for clarity, those are not shown on this map.

ladder of civil-religious posts (*cargos*, lit. "burdens") that each citizen must climb over the course of their adult life. *Cargos* include positions that directly relate to the provisioning of public goods, including public safety, infrastructure, and the administration of communal resources. Failure to accept a *cargo* when nominated by the Communal Assembly of citizens can result in punishment. However, while *cargo* systems are widespread across Oaxaca, there is substantial institutional variation. For example, there is variation in the number of years of service a citizen must give before "retiring" (ranging from 5 years to 40 years) and the severity of sanctions for refusing to serve when nominated (ranging from no sanction to expulsion from the community) (Instituto Estatal Electoral de Oaxaca, 2003).

Drawing on cultural evolutionary theory, we hypothesized that Oaxacan communities with stronger traditional political institutions mobilize greater collective action, improving the provisioning of public goods. Within this framework, "strong" institutions are those that (1) comprise more powerful norms about service to the community; (2) levy harsher sanctions against non-cooperators; and (3) build interdependence. To test this hypothesis, we first constructed theoretically-motivated measures of institution strength for the 418 Oaxacan municipalities run under *usos y costumbres*. Then, leveraging secondary data, we examined whether institution strength predicts the community's ability to (1) mobilize cooperation and (2) provide public goods such as drinking water. Our results indicate that communities with stronger *usos y costumbres* institutions galvanize more labor for the group benefit (such as participation in *cargos*) and more remittances from migrants for public works projects. However, we find limited evidence that tangible public goods outcomes are associated with institution strength.

Below, we begin by providing deeper background on Oaxacan traditional political institutions, including existing research on how they contribute to cooperative outcomes. We then lay out a pre-registered cultural evolutionary framework for thinking about how Oaxacan traditional political institutions shape cooperation within communities. When then detail the hypotheses, describe the data, and present results.

2. Background on Oaxacan traditional political institutions

Contemporary *usos y costumbres* institutions have hybrid origins. These are not static institutions springing directly from pre-Columbian indigenous traditions; rather, they represent the blending of indigenous and Spanish practices. For example, consider the origins of the *cargo* system. There is some evidence that *cargo*-like social organization may have existed in the pre-

Columbian period. However, the Spanish instituted a new system of civil-religious posts which, when layered atop existing indigenous practices, gave rise to the colonial *cargo* system. This system has seen many changes in structure and function in the intervening centuries (Carrasco, 1961; Chance & Taylor, 1985; Chassen-López, 2004b), taking different paths in different communities (Nader, 1964). Throughout colonialization, the revolutionary era, and periods of modern reform, indigenous communities have actively engaged outside forces to safeguard their lands, rights, and cultures. At the same time, these communities have experienced many changes– sometimes by force, sometimes by choice (Benton, 1999; Chassen-López, 2004a; Nader, 1964, 1989).

Several factors contributed to the state constitutional reforms that formally granted autonomy to Oaxacan indigenous communities in the 1990s. In the decades leading up to the reforms, popular movements lead by students, workers, and peasants rocked the state, weakening the legitimacy of the ruling political party, *el Partido Revolucionario Institucional* (PRI). Tracking this loss of footing, PRI began to lose electoral contests in Oaxaca from the 1970s onward. Indigenous movements emerged in the 1980s in Oaxaca, as community leaders began to push for recognition of indigenous culture and the legal right to control their land and natural resources. Similar mobilizations were already rolling in the neighboring state of Chiapas, where PRI responded harshly. Tensions ratcheted up in the early 1990s, culminating in the outbreak of the armed Zapatista rebellion in Chiapas in 1994. In Oaxaca, the violent struggle of the Zapatistas in Chiapas inspired mass mobilizations for indigenous rights and autonomy (Muñoz, 2005). Facing the double threat of declining legitimacy and destabilizing popular movements within the state, PRI instituted reforms granting special rights and autonomy to indigenous communities of Oaxaca, including the formal recognition of *usos y costumbres*. This was likely a strategic effort aimed at heading off violent indigenous uprising in Oaxaca and, potentially, preventing rival

political parties from gaining footing in Oaxacan municipalities (Eisenstadt & Yelle, 2012; Muñoz, 2005). Whatever the motive, the reforms opened the door to formalized legal pluralism in Oaxaca.

Today, *usos y costumbres* systems across Oaxaca share several common features, including communal assemblies, obligatory service to the community, and sanctions against non-cooperators.

2.1 Communal decision-making

Within *usos y costumbres* communities, the Communal Assembly of citizens holds the highest power. During assemblies, people discuss, debate, and then vote, often by raised hand, marks on a chalkboard, or applause (INEGI, 2009). There are usually several regularly scheduled assemblies each year that serve specific functions, such giving community leaders the opportunity to provide updates about progress on projects or seek authorization for spending community funds. However, additional assemblies can be called when an important issue arises (González Rojas, 2016). For example, during the COVID-19 pandemic, communities convened assemblies to decide how to address the threat, with many ultimately shutting town borders and instituting mask mandates (Curtin et al., 2024). *Ad hoc* assemblies can also convene to decide how to deal with rule-breakers or resolve conflicts (Curtin et al., 2024; González Rojas, 2016; Instituto Estatal Electoral de Oaxaca, 2003).

2.2 Obligatory community service: *cargos*, *tequios*, and *cooperación*

Community function depends on services rendered by citizens in the form of labor, time, and money. The most notable community service institution is the *cargo* system. *Cargo*-holders administer community resources, organize public works projects, and provide public safety. *Cargos*

also include religious posts, which can involve organizing and funding patron saint festivals. When elected to a *cargo* by the Communal Assembly, citizens are required to serve 1-3 year-long unpaid terms (Instituto Estatal Electoral de Oaxaca, 2003). Top *cargos*, such as municipal president, take the place of the *cargo*-holder's normal occupation or subsistence activities, making them extremely burdensome (Curtin et al., 2024; de la Fuente, 1949; Nader, 1964; Polo & Danielson, 2013). Service obligations also include filling a yearly quota of days laboring on public projects such as road maintenance or water pipe repairs (*tequio*) and cash contributions to the community coffers (*cooperación*) (Cohen, 1999; Curtin et al., 2024; de la Fuente, 1949; Nader, 1964).

2.3 Communal control of resources

In most towns, the community collectively controls its natural resources. Indigenous Oaxacans have traditionally relied on subsistence agriculture, cultivating small plots that can be held by and inherited within a family, but ultimately belong to the community. Residents also rely on communally-owned forests for gathering firewood, the primary cooking fuel in many communities (INEGI, 2010). Some communities have dedicated portions of communal forests to timber production as a means of income, while other areas are set aside for non-timber products (such as mushrooms), wildlife refuges, and water catchments (Chapela, 2005). Decisions about how to manage communal lands are typically made by the Communal Assembly, while *cargo*-holders administer the communal resources and patrol lands to prevent unauthorized extraction (Chapela, 2005; Curtin et al., 2024). Speaking to the importance of communally-controlled resources, Oaxaca is rife with agrarian conflict, particularly over lands with water sources (Dennis, 1987; López-Bárcenas, 2004).

2.4 Within-group justice

Communities punish citizens who fail to abide by their rules. Commonly sanctioned violations include: skipping a Communal Assembly, disrupting the Communal Assembly, shirking *tequio* (communal labor), refusing to serve a *cargo*, inadequate performance or corruption in a *cargo*, wasting water, and selling communal land to an outsider (Curtin et al., 2024; González Rojas, 2016; Instituto Estatal Electoral de Oaxaca, 2003; Nader, 1964). The severity of sanctions for different violations varies between communities, but can include no sanction, weaker sanctions (a fine; brief jail time), stronger sanctions (cutting off electricity, water, or sewerage service; confiscating agricultural lands; loss of community rights), or, at the most extreme, expulsion from the community (Curtin et al., 2024; Danielson, 2013; Instituto Estatal Electoral de Oaxaca, 2003).

2.5 Citizenship and corporate identity

Finally, indigenous Oaxacan communities have norms regarding citizenship and endogamy that contribute to their corporate nature. Under *usos y costumbres*, communities define their own rules of citizenship: who possesses rights to hold land, vote in assemblies, and serve *cargos*. Traditionally, only "children of the village" (people from the town) were considered citizens (Martínez, 2013). This meant that immigrants could not gain citizenship, hold land, or participate in community governance. In some places, restrictions on outsiders still stand. For example, 13% *usos y costumbres* municipalities bar new residents from ever gaining the right to vote in assemblies, and 25% prevent them from ever serving *cargos*. In some municipalities, outsiders can gain some of these rights after fulfilling certain criteria (such as a certain length of residency), while in others, outsiders can exercise community rights immediately (Bustillo Marín, 2016). Finally, many

communities show a strong preference for village endogamy in marriage (Chance, 1989; Dennis, 1987; Fry, 1992; Kearney, 1972; Nader, 1964; Selby, 1974).

Together, these forces likely promote the formation of a corporate identity, limiting between-community residential mobility (physical movement to a new town or region) and relational mobility (the ability to break old social ties and build new ones). In line with this, anthropologists have argued that Oaxacan indigenous communities function as corporate entities analogous to kin-based lineages. Chassen-López (2004) suggests that, with the breakdown of complex kin ties in the wake of Spanish colonialism, land-holding kin-based lineages were replaced with "place-based" units. Similarly, Dennis (1987: 33) argues that Oaxacan indigenous communities are "the functional equivalents of the lineages and clans of tribal society… [with] such marks of corporate identity as myths about how they came to be founded, rules of membership, and continuity over time."

2.6 Existing research on the relationship between *usos y costumbres* and cooperation

In line with recent calls to reconsider the role of traditional political institutions in economic development (Baldwin & Holzinger, 2019; Lust & Rakner, 2018), several studies have explored how *usos y costumbres* institutions shape cooperative outcomes in Oaxacan communities. First, there is evidence that municipalities run under *usos y costumbres* provide drinking water more equitably than those run under the Mexican party system. Using a regression discontinuity approach, Magaloni et al. (2019) examined the provisioning of drinking water and sewerage to households along boundaries between *usos y costumbres* and party-run municipalities. The authors' analysis identifies a causal impact of *usos y costumbres* on drinking water provisioning: within 500m from the boundary, 10 percentage points more households were without drinking water in party-

run municipalities. They found no significant effects of governance style on sewerage coverage. The authors argue that the ability of *usos y costumbres* municipalities to better distribute water relates to (1) greater accountability of local leaders, (2) collective decision making, and (3) the system of community service that promotes cooperation (Magaloni et al., 2019). However, while this study provides compelling evidence of a causal impact of *usos y costumbres* on public goods outcomes in Oaxaca, it does not address institutional variation between *usos y costumbres* municipalities.

Focusing on this variation, several studies indicate that *usos y costumbres* communities with stronger institutions may promote greater cooperation. Specifically, communities with more demanding obligations for migrants and harsher sanctions for non-compliant migrants extract more resources from them. First, VanWey et al. (2005) compared community organization and migrant participation in four Zapotec communities. Based on extensive interviews about *usos y costumbres* practices related to *tequios*, *cargos*, and migrant participation, the researchers classified two of the communities as "highly organized", while the other two were "less organized". In the two less organized communities, migrants sent remittances only to their families. In contrast, in the highly organized communities, the local government was able to access migrant resources through fines for missed *tequios* and donations for festivals and infrastructure maintenance (VanWey et al., 2005). Thus, in this case study, communities with stronger institutions were able to extract greater cooperation from migrants living elsewhere. Danielson (2013) asked a similar question, expanding to compare across all Oaxacan *usos y costumbres* municipalities. He ran an extensive survey of top *cargo*-holders in 417 of the 418 *usos y costumbres* municipalities, gathering data about social organization, local governance, and community participation. Focusing on migrant participation, Danielson (2013) found a positive correlation between migrant obligations

for financing public works and actual migrant contributions. Moreover, he found positive correlations between the presence of sanctions for migrants refusing *cargos* and actual migrant participation in the *cargo* system (Danielson, 2013). Although based on simple pairwise correlations, Danielson's (2013) study provides further evidence that the strength of traditional political institutions in Oaxaca may be associated with cooperative outcomes.

3. Oaxacan traditional political institutions and cooperation: a cultural evolutionary perspective

Drawing from cultural evolutionary theory, we build on this literature to hypothesize that Oaxacan communities with stronger traditional political institutions foster greater cooperation, improving the provisioning of public goods. Although researchers have made important efforts to document institutional differences between Oaxacan *usos y costumbres* municipalities (e.g. Danielson, 2013; Bustillo Marín, 2016; Nader, 1964; Polo & Danielson, 2013; VanWey et al., 2005), this is the first attempt to quantify the overall strength of these institutions as they relate to cooperation. Here, we highlight several dimensions along which *usos y costumbres* institutions vary and use a cultural evolutionary framework to make predictions about how the variation should impact cooperation.

3.1 Social norms about service to the community

Usos y costumbres institutions are packages of social norms governing citizenship and civic participation. Norms about service to the community, including *cargos* and *tequios*, are an important part of this package (Curtin et al., 2024). Cultural evolutionary theory suggests that cooperative norms like these can mold people's psychology as they grow up. Through the process of norm internalization, norms become intrinsic motivations, preferences, and biases (Chudek & Henrich,

2011; Henrich & Muthukrishna, 2021). Thus, people living in communities with powerful norms about service ("accepting a *cargo* is the right thing to do", "people should always go to *tequio*") may have higher intrinsic motivation to participate in service. In line with this, our recent work in one Zapotec village showed that men who made harsher judgments about *usos y costumbres* norm violations (e.g. skipping *tequio*) were more likely to fulfill their duties of service to the community (Curtin et al., 2024). Therefore, we expected that communities with stronger norms about *cargos* and *tequios* would be able to mobilize more cooperation. Because the services rendered by citizens in these communities directly facilitate the provisioning of public goods, we further hypothesized that stronger norms would lead to improved public goods outcomes.

3.2 Punishment of non-cooperators

Punishment is an important mechanism for stabilizing cooperation and cooperative norms, as demonstrated by formal evolutionary models (Boyd et al., 2010; Henrich & Boyd, 2001; Jordan et al., 2016; Noblit & Henrich, 2023), lab studies (Fehr & Fischbacher, 2004; Fehr & Gächter, 2002), and field studies (Curtin et al., 2024; Mathew & Boyd, 2011). As discussed in section 2.4, sanctions against non-cooperators are a notable feature of the traditional political institutions of many Oaxacan communities. Moreover, our recent work in one Zapotec community suggests that formalized sanctions play an integral role in stabilizing norms related to service, including *cargos* and *tequios* (Curtin et al., 2024). We therefore expected that communities with harsher sanctions against non-cooperators would be better able to stabilize cooperation and collective action, leading to improved provisioning of public goods.

3.3 Building interdependence via communal control of resources

Cultural evolutionary theory suggests that communal control of resources can enhance cooperation within groups by building interdependence. Evolutionary anthropologists have proposed that humans have an evolved "interdependence psychology" that supports cooperation between people whose fitnesses are intertwined (Aktipis et al., 2018; Henrich, 2020; Henrich & Muthukrishna, 2021; Roberts, 2005; Tomasello et al., 2012). When corporate groups collectively control important resources, this can generate interdependence because the wellbeing of each group member in part relies on other group members (Cronk et al., 2019; Henrich, 2020). For example, consider a scenario in which men are collectively responsible for defending their communal lands against outside threats. When one man falls ill and is unable to contribute to border patrol, the wellbeing of other group members may suffer– outsiders may seize some of the land, stealing important resources. Thus, people should be motivated to help the sick man recover, since their own wellbeing depends on it. In line with this, research has shown that "mutual dependence"– in the form of communal customary land rights in Africa– increases expectations of cooperation among group members (Harris & Honig, 2023). Interdependence within communities should be particularly strong when residential and relational mobility are low. In both cases, low mobility makes it more difficult for individuals to leave their corporate group and access external resources. It may also enhance interdependence in the form of shared genes by increasing relatedness within the community (inclusive fitness). Given the corporate nature of Oaxacan *usos y costumbres* communities, interdependence seems highly relevant to the Oaxacan context. Building on this, we hypothesized that communities that collectively control a large portion of local lands would foster greater cooperation through interdependence.

3.4 Specific hypotheses

We pre-registered the following specific hypotheses (https://tinyurl.com/TPIsOSF2). First, if stronger institutions mobilize more cooperation, then town leaders in communities with stronger institutions should report that citizens participate to a greater degree in community service activities such as *cargos* and *tequios*. In addition, migrants from communities with stronger institutions should be more likely to contribute money to public works projects. Second, if stronger institutions improve public goods outcomes, then towns with stronger institutions should (1) provide a greater number of public goods, such as street cleaning, trash pickup, and paved streets and (2) provision a larger proportion of households with piped water and sewerage service. We also hypothesized that communities with stronger institutions would better manage their lands, which we expected to result in lower levels of soil erosion. Finally, based on ethnographic observations of the importance of community cooperation in wildfire prevention and control (Curtin et al., 2024), we hypothesized that communities with stronger institutions would control wildfires more quickly.

4. Data

4.1 Measuring institution strength

We created four theoretically-motivated measures of institution strength, aiming to capture (1) the strength norms about service to the community, (2) the severity of punishment for non-cooperators, and (3) the degree of interdependence within the community. After establishing that these four indicators were generally linearly associated with outcomes and all loaded in the same direction onto the first principal component of a PCA (see Supp SB1.4), we averaged them to create an **Institution Strength Index** (Figure 2).

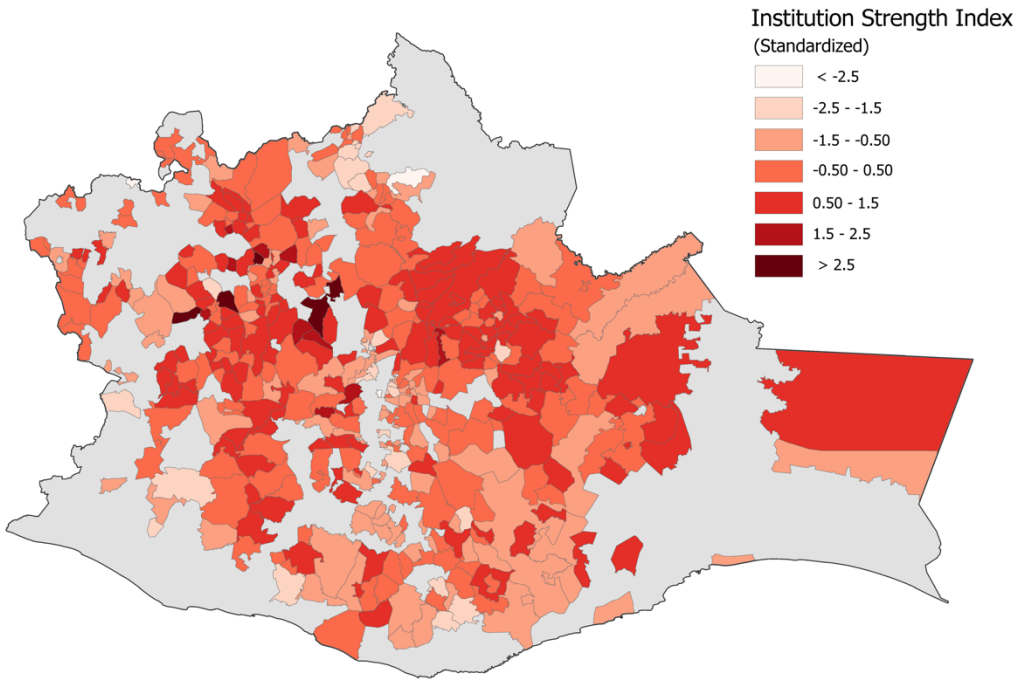

Figure 2. Institution Strength Index. For *usos y costumbres* municipal seats, this index averages across four sub-indicators: Voting Requirements Index, *Cargo* Ratio, Sanction Severity Index, and Communal Land Tenure.

4.1.1 Burden of service to the community

Specific data about the strength of social norms were not available, so instead we included two sub-indicators that capture the burden of service that citizens must give to the community. We argue that more stringent requirements about participation in *cargos* and *tequios* likely indicate stronger norms, providing an indirect measure of norms about service. First, the **Voting Requirements Index** measures the obligations that a citizen must meet in order to preserve their right to vote in Communal Assembly. Although active participation in the Assembly is an essential right for citizens of *usos y costumbres* communities (Bustillo Marín, 2016), there is variation in the obligations that citizens must fulfill to fully participate. While citizens of some communities preserve their right to vote regardless of whether they serve the community, others must give both *tequio* and *cargos*. Based on data compiled by Bustillo Marín (2016), we create a Voting

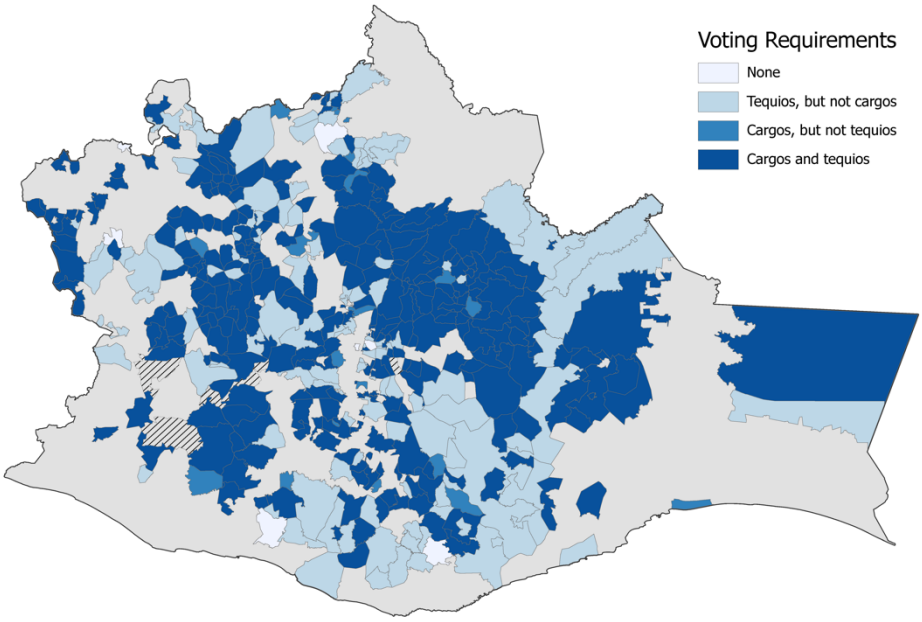

Figure 3. Voting Requirements Index. For Oaxacan *usos y costumbres* municipal seats, this map shows the requirments that citizens must meet in order to preserve their right to vote in the Communal Assembly. Missing data are indicated with hatching.

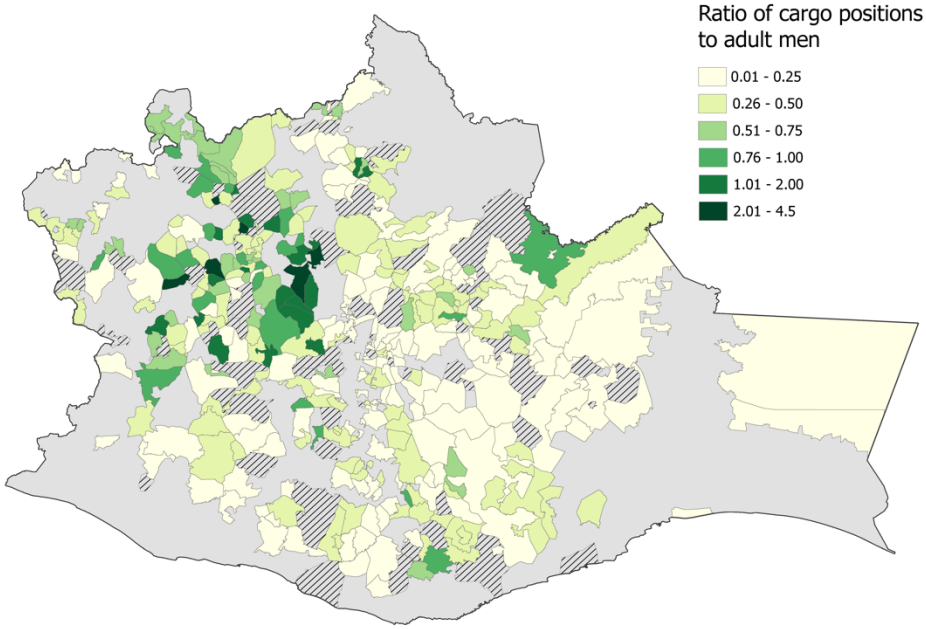

Figure 4. *Cargo* Ratio. This map shows the ratio of total number of *cargo* positions to adult men (>18) in Oaxacan *usos y costumbres* municipal seats. Missing data are indicated with hatching.

Requirements Index which is equal to 0 when there are no requirements; 1 when a citizen must give *tequio* but not *cargos*; 2 when they must give *cargos* but not *tequios*; and 3 when they must give both *cargos* and *tequios* (Figure 3).

Second, we created the ***Cargo* Ratio**, which captures the lifetime burden of *cargo* service. Ideally, we would use the number of years that a citizen must serve over their lifetime, according to community norms. However, these data were only available for 185 out of 418 municipalities. As a compromise, we calculated the ratio of *cargo* positions to adult men in the community– the segment of the population that typically serves *cargos* (Figure 4; see SB1.2 for a discussion of the roles of women and migrants in the *cargo* system). This is a mechanical measure of the burden of *cargo* service: holding male population constant, men in communities with more *cargos* will serve more frequently than men in communities with fewer *cargos.*

Data about *cargos* come from the 2003 *Catálogo Municipal de Usos y Costumbres*. This catalog was produced by Oaxaca's Office of State Elections and Citizen Participation (*Instituto Estatal Electoral y de Participación Ciudadana de Oaxaca*). It consists of a collection of PDF files detailing the traditional political institutions in municipal seats run under *usos y costumbres*, sourced directly from the leadership in each municipality. Each municipality's PDF contains a section titled, "*Cargos* that exist in the community", which lists the *cargo* titles and number of positions (e.g. Police: 15, Councilor of Health: 1). A team of 4 coders each read through a portion of the PDFs, counting the total number of *cargos*. One of the coders then conducted a blind crosscheck of a random selection of 10% of cases. The cross-check revealed a low error rate of 4.5%. The *Cargo* Ratio was calculated as the total number of *cargo* positions divided by the number of men above the age of 18 in the municipal seat census locality, according to data from the 2010 Census.

4.1.2 Sanction Severity Index

To quantify the severity of sanctions within *usos y costumbres* communities, we drew on two sources: (1) ethnographic data about the sanctions that exist in each *usos y costumbres* municipal seat and (2) survey data about severity of different types of sanctions.

First, we coded ethnographic data about the sanctions that exist in each community from the 2003 *Catálogo Municipal de Usos y Costumbres*. Each municipality's PDF contains a section titled, "On community sanctions", which specifies the punishments for six violations, four of which directly relate to cooperation and public goods: skipping a *tequio*; skipping a Communal Assembly; refusing to accept a *cargo*; and doing an inadequate job in one's *cargo*. Two coders coded the sanctions from a set of fifteen categories (e.g. "jail", "fine", "expulsion from community", see Table 1 for the full list of categories) for each violation in each community. Coders could also classify the sanction as a combination of other sanctions (e.g. "fine and *tequio*"); various possible sanctions (e.g. "fine or *tequio*"); or something else. A third researcher compared their answers, identifying cases where the original coders disagreed. Disagreements wherein one coder had made an error (2% of 2,496 total cases) were fixed, while true disagreements (7.6%) were adjudicated through discussion.

To quantify the severity of each sanction within the Oaxacan context, we conducted a Qualtrics survey of indigenous Oaxacans from communities run under *usos y costumbres* (N = 22). Participants were presented with pairs of sanctions and asked, "In your opinion, which would be worse for you?". Each participant saw a random subset of 20 pairs of sanctions, generating a total of 436 pairwise comparisons. Afterwards, we artificially added two observations per participant, each pairing a randomly selected sanction with "no sanction" as the "loser" in the comparison (generating a final total of 480 pairwise comparisons). "No sanction" had not been included as an

Table 1. Sanction Severity Mean Elo Scores

Sanction	**mElo Score**
None	0
Warning	236
Communal labor (*tequio*)	287
Admonishment or scolding	375
In-kind fine (e.g. construction materials)	381
Fine of 1 day's wages	453
Marginalized or ignored	603
Jail	626
Fine (amount not specified)	635
Removal from *cargo*	786
Jail and fine	841
Denial of administrative services	886
Stripped of rights as a citizen	936
Cut off basic services to house (water, sewerage)	1023
Confiscation of lands or property	1143
Expulsion from community	1156

Notes: Oaxacans ($N = 22$) from *usos y costumbres* communities responded to a set of pairwise comparisons asking them which of two sanctions would be worse for them. These data were run through an Elo algorithm to generate mean Elo (mElo) Scores of sanction severity. The continuous mElo values were transformed so that "no sanction" equals 0.

option in the Qualtrics survey; however, we realized that it would be important for benchmarking the severity of the least severe sanction. We believe that it is reasonable to assume that "no sanction" is always less bad than a sanction.

We then ran the pairwise comparison data through an Elo algorithm (R package "EloChoice") to generate mean Elo (mElo) Scores of severity for each sanction. Elo algorithms were originally created to rank chess players by skill, based on match wins and losses. However, social scientists have begun to apply this technique to quantify the perceived attributes of items on a scale (Clark et al., 2018; Routh et al., 2023). Elo algorithms produce continuous, relative ratings of items using pairwise comparison data (Routh et al., 2023). Because Elo Scores are sensitive to

the order in which comparisons are entered into the algorithm, mean Elo (mElo) Scores were generated by averaging across 1000 randomized iterations. While the number of survey participants was small, the Consistency Index for the mElo Scores stabilizes at about 0.9 out of 1 with roughly 13 participants (Figure B1). This suggests that a larger sample size would be unlikely to change the results. For ease of analysis, the raw mElo Scores were transformed to all positive values, setting "no sanction" equal to zero (Table 1).

To create the **Sanction Severity Index**, we matched severity mElo Scores to each coded violation from the 2003 *Catálogo Municipal de Usos y Costumbres* (see SB1.1.3 for details about how we dealt with ambiguous cases). For each community, we then averaged mElo Scores across the 4 violations that most directly relate to cooperation and public goods: skipping *tequio*, skipping a Communal Assembly, refusing a *cargo*, and doing an inadequate job in a *cargo*. Across 418 *usos y costumbres* municipalities, the Sanction Severity Index ranges from 0 (none of the violations are sanctioned) to 948 (roughly equivalent to the severity of being stripped of one's rights as a citizen of the community), with a mean of 428 (roughly equivalent to a fine of one day's wages) (Figure 5). We standardized the index– low values indicate lenient sanctions and high values indicate harsh sanctions.

4.1.3 Communal land tenure

We calculated the proportion of land within each municipality that is communally held under the *comunidades agrarias* scheme, based on data from the 2016 Agricultural Census (Figure 6). An important caveat is that this measure is only available at the level of the whole municipality. Because many municipalities include smaller outlying hamlets which are ruled by

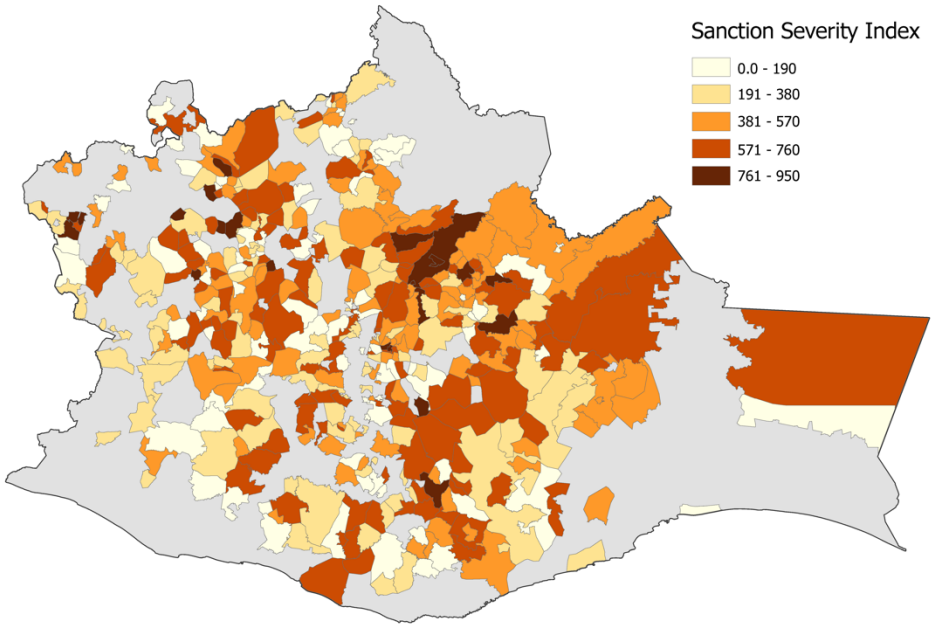

Figure 5. Sanction Severity Index. In *usos y costumbres* municipal seats, the Sanction Severity averages across the severity of punishment for four cooperation-related violations: skipping *tequio*, skipping communal assembly, refusing a *cargo*, and doing a poor job in a *cargo*. A value of 0 means that none of the 4 violations are sanctioned. The mean value (428) is roughly equivalent to a fine of one day's wages. The maximum value (948) is roughly equivalent to the severity of being stripped of one's rights as a citizen of the community.

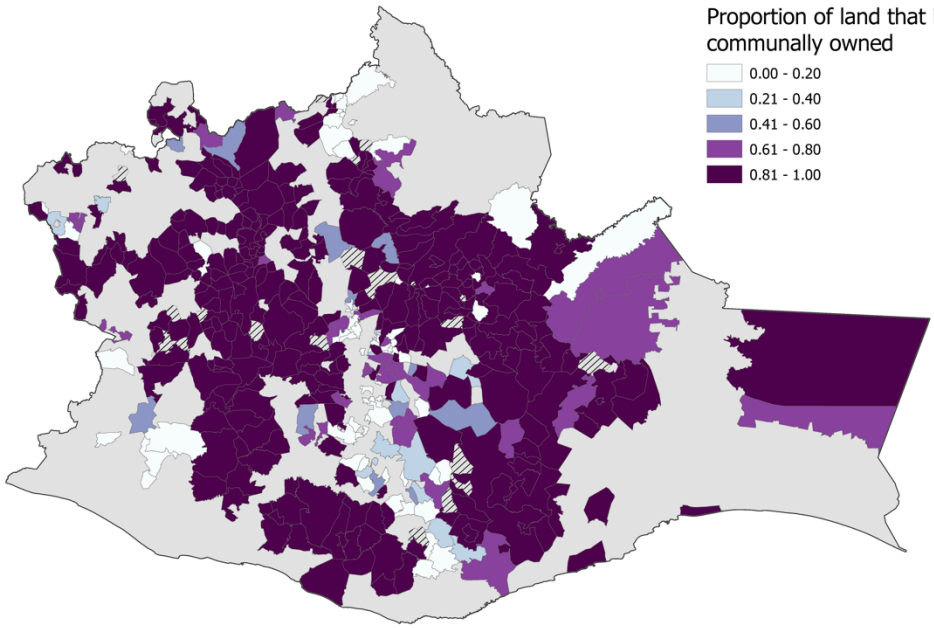

Figure 6. Communal land tenure. This map shows the proportion of municipal land that is communally owned under the *comunidades agrarias* scheme. Missing data are indicated with hatching.

their own *usos y costumbres*, this variable has some error in it.

4.2 Outcomes

4.2.1 Measures of the community's ability to mobilize cooperation

We measured the community's ability to mobilize cooperation in two ways. First, we created a **Service Participation Index** that captures the level of citizen participation in *cargos* and *tequios*. The Index is based on data from the 2008 Survey of Oaxaca, Mexico Customary Law Municipalities, a survey of leaders in municipal seats (Danielson, 2013; Polo & Danielson, 2013). One set of questions in the survey asked leaders to report, "In your opinion, what is the level of participation in the community in the following activities or functions?", inquiring about *tequio, cargos* in the town hall, commission *cargos*, police and *topil cargos*, religious *cargos*, and patron saint festivals. Response options were "a minority participates", "the majority participates", and "everyone participates". To build the Service Participation Index (N = 371), we constructed a first principal component-weighted average of responses about the non-religious services: *tequio, cargos* in the town hall, commission *cargos*, and police and *topil cargos*. We excluded participation in religious *cargos* and patron saint festivals, since this may be influenced by the religious makeup of the community (i.e. the proportion of Evangelicals).

Second, we measured migrant participation, again drawing on data from the 2008 Survey of Oaxaca, Mexico Customary Law Municipalities. We included two measures of migrant contributions to public works. First, the **Migrant Cooperation** dummy variable takes a value of 1 if leaders report that migrants "cooperate economically" (send remittances) for public works (N = 343). Second, the **Recent Migrant Public Works** dummy variable equals 1 if migrants had contributed to at least 1 public works project during the prior four years (N = 376).

4.2.2 Measures of public goods provisioning

Our first set of public goods outcomes relate to the provisioning of goods and services within the community. Based on locality-level data from the 2010 Census, the **Public Goods Index** (N = 364) quantifies the number of public goods and services available in the municipal seat. The index averages across 10 binary variables indicating the presence of: street cleaning, trash pickup, street lighting, paved streets, a community well, a drinking water network, a cemetery, a jail, a community basketball court, and a library. Next, we calculated the proportion of households in the municipal seat locality that have (1) piped water and (2) sewerage service, based on data from the 2010 Census (N = 418).

Second, we measured levels of soil erosion and soil degradation on municipal lands. Average severity of soil erosion and degradation (erosion, physical degradation, and chemical degradation) within the municipality were calculated using geographic data from the *Secretaría de Medio Ambiente y Recursos Naturales* (N = 418). Note that these variables are municipality-level. Because many municipalities include smaller outlying hamlets (*agencias*) which are ruled by their own *usos y costumbres*, these variables have some error.

Finally, data on fires in Oaxaca between 2015-2020 come from a geographic dataset produced by the *Comisión Nacional Forestal*. We calculated the area (hectares) of land burned during each fire that occurred on municipal seat lands during the five-year period (N = 503 fires, clustered within 192 municipalities).

A full list of variables and sources can be found in the Supplement Materials (SB1.5).

5. Empirical strategy

5.1 Pre-registered analyses

We followed a pre-registered analysis plan (https://tinyurl.com/TPIsOSF2). While our analyses are correlational, we aimed to reduce omitted variable bias by including many covariates in the models. As a general strategy, we placed emphasis on geographic covariates, such as proximity to cities and terrain ruggedness. Demographic features of the population (e.g. poverty, education, and employment rates) could be impacted by the institutions. Therefore, including them in the model may cause post-treatment bias– muddling the estimation of the treatment effect of institution strength. When predicting measures of cooperation, however, it is theoretically quite important to control for demographics. For example, employment rate in the community may influence the level of participation in *cargos* and *tequios*– people who are employed may be more inclined to skip *tequio* or refuse a *cargo* because it conflicts with their wage labor. However, because employment rates may be impacted by the local institutions, post-treatment bias poses a threat.

To address this issue, we include geographic covariates that offer plausibly exogenous routes to demographic features that may impact participation. Factors such as proximity to cities, ports, railroads, and roads may encourage higher rates of market integration and participation in wage labor (plausibly exogenous routes to higher employment rate). Lack of economic opportunity locally (perhaps due to features like geographic isolation, poor suitability for cash crops) may favor outmigration of able-bodied adults (plausibly exogenous routes to migration intensity, female-biased sex ratio, excess of old people and children). Similarly, in models predicting outcomes related to public goods provisioning, the key goal of the covariates was to control for exogenous routes to wealth and economic development (e.g. suitability for cash crops).

Following the standard approach in economics, we therefore control for basic geographic and climate features (latitude, longitude, mean annual precipitation, mean annual temperature); geographic isolation (altitude, terrain ruggedness (Nunn & Puga, 2012), distance to the nearest city, port, railroad, and highway); and geographic features associated with wealth (suitability for the staple crop, maize; suitability for cash crops coffee, sugarcane, and cacao; and distance to the nearest gold or silver mine). Because the *Cargo* Ratio only makes sense as a predictor when holding population size constant, we include the log of total population in most models. In some models, we also include basic demographic and economic covariates: average educational attainment, employment rate, sex ratio, proportion of households with a dirt floor, and proportion of the population that is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

Continuous outcomes were analyzed with Ordinary Least Squares regression (OLS), while binary outcomes were analyzed with logistic regression (logit). As an illustration of the basic linear specification, for municipal seat *s* in ethnolinguistic group *i*:

$$Y_{si} = \beta_0 + \beta_1 Institution_{si} + \alpha_i + \theta_{si} + \varepsilon_{si}$$

where:

- Y is a continuous outcome variable, e.g. Service Participation Index or Proportion of Households with Drinking Water
- $Institution$ is the Institution Strength Index
- α is an ethnolinguistic group-specific intercept
- θ is a vector of covariates
- ε is the error term

To examine the possibility that sub-indicators of institution strength have differential impacts on outcomes (e.g. do sanctions play a larger role than communal land tenure?), we ran

models that included individual sub-indicators as predictors. For municipal seat *s* in ethnolinguistic group *i*:

$$Y_{si} = \beta_0 + \beta_1 Sanction_{si} + \beta_2 Cargo_{si} + \beta_3 Vote_{si} + \beta_4 Communal_{si} + \alpha_i + \theta_{si} + \varepsilon_{si}$$

where:

- Y is a continuous outcome variable, e.g. Service Participation Index or Proportion of Households with Drinking Water
- $Sanction$ is the Sanction Severity Index
- $Cargo$ is the *Cargo* Ratio
- $Vote$ is the Voting Requirements Index
- $Communal$ is Proportion of Land that is Communally Owned
- α is an ethnolinguistic group-specific intercept
- θ is a vector of covariates
- ε is the error term

Finally, when analyzing wildfire size, we used Linear Mixed Effects Regression (R package lme4, version 1.1–23) with random intercepts for municipal seats nested within ethnolinguistic groups. We included covariates that we expected to impact wildfire activity in these models: average geo-climatic fire risk, year in which the fire occurred, month in which the fire occurred, and distance of fire location from municipal seat.

5.3 Exploratory analyses

In addition to our pre-registered analyses, we did several exploratory analyses. First, we explored possible mechanisms through which institution strength may impact migrant remittances. Danielson's (2013) data set includes a dummy variable that equals 1 when migrants

are *required* to contribute to public works projects. His pairwise correlation analyses suggested that contributions were strongly associated with requirements, while also revealing that migrants often contribute even when not required. We (1) tested whether our measures of institution strength predicted migrant contribution requirements and (2) included a contribution requirement dummy as a control when predicting actual migrant contributions.

Second, for 104 communities in which migrants are required to return to serve a *cargos*, Danielson (2013) collected data about the punishment for defectors. Using the same method described above (Section 4.1.2) we constructed a Migrant Sanction Severity Index that captures the severity of punishment for migrants who refuse to return to serve when required to do so. To explore the possibility that communities with harsh sanctions for local defectors also harshly punish uncooperative migrants, we tested whether the Sanction Severity Index and Migrant Sanction Severity Index were correlated.

Next, we broke down the Public Goods Index to examine the likelihood of having individual goods and services. Exploration of the data revealed very little variation in the presence of some goods and services; for example, nearly all *usos y costumbres* communities have a basketball court, cemetery, and jail. Focusing on services for which there was substantial variation, we tested whether measures of institution strength predict the presence of trash pickup, street cleaning, paved streets, and a police force. Also, after testing our pre-registered hypothesis about soil erosion, we included soil degradation of all forms (erosion, chemical degradation, and physical degradation) as an outcome.

Finally, we examined whether the estimated effects of institution strength vary with population size. To do this, we interacted the log of total population size with Institution Strength Index on outcomes.

6. Results

Here, we show that Oaxacan communities with stronger traditional political institutions extract more cooperation from community members for the group benefit, including (1) higher levels of participation in *cargos* and *tequios* and (2) more migrant remittances for public works projects. Results suggest that these effects are strongest in large communities. However, we find limited evidence that stronger traditional political institutions are associated with tangible public goods outcomes, such as the provisioning of drinking water and sewerage service.

6.1 Mobilizing cooperation

As institution strength increases, so does the reported level of participation in *cargos* and *tequios*: a one standard deviation increase in Institution Strength Index is associated with a 0.20 standard deviation increase in Service Participation Index ($\beta = 0.20$, 95%CIs[0.08, 0.31], $p < 0.05$, Table 2, Column 1), although as covariates are added, the coefficient shrinks slightly and the estimate loses some precision. When sub-indicators of institution strength are included in the model instead, analyses reveal that both Sanction Severity Index and communal land tenure are robust predictors of Service Participation Index, standing up to all covariates. A one standard deviation increase in the Sanction Severity Index and proportion of land that is communally

Table 2. Mobilizing cooperation: Service Participation Index

	Service Participation Index					
	(1)	(2)	(3)	(4)	(5)	(6)
Institution Index	0.197**	0.137*	0.153*	0.130+	0.133+	0.139+
	(0.08, 0.31)	(0.01, 0.27)	(0.02, 0.29)	(-0.01, 0.27)	(-0.01, 0.27)	(0.00, 0.28)
Communal Land	0.187**	0.154*	0.162*	0.148*	0.137+	0.160*
	(0.06, 0.31)	(0.03, 0.28)	(0.04, 0.29)	(0.01, 0.29)	(-0.01, 0.28)	(0.01, 0.31)
Vote Requirements	-0.008	-0.019	-0.013	-0.017	-0.006	-0.010
	(-0.13, 0.11)	(-0.14, 0.10)	(-0.13, 0.11)	(-0.14, 0.10)	(-0.13, 0.12)	(-0.14, 0.12)
Cargo Ratio	-0.025	-0.137	-0.087	-0.065	-0.079	-0.098
	(-0.16, 0.11)	(-0.30, 0.03)	(-0.25, 0.08)	(-0.23, 0.10)	(-0.25, 0.09)	(-0.27, 0.08)
Sanction Severity Index	0.138*	0.125*	0.126*	0.126*	0.127*	0.141*
	(0.02, 0.26)	(0.01, 0.24)	(0.01, 0.24)	(0.01, 0.24)	(0.01, 0.25)	(0.02, 0.26)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes	Yes
log(Population)	No	Yes	Yes	Yes	Yes	Yes
Basic Geographic	No	No	Yes	Yes	Yes	Yes
Geographic Isolation	No	No	No	Yes	Yes	Yes
Geo. Wealth Potential	No	No	No	No	Yes	Yes
Demographics	No	No	No	No	No	Yes
Obs. (Institution Index)	347	347	341	339	339	339
R^2	0.125	0.135	0.173	0.197	0.207	0.219
Adjusted R^2	0.082	0.090	0.122	0.130	0.127	0.117
Residual Std. Error	0.958	0.954	0.933	0.930	0.932	0.937
F Statistic	2.936***	3.018***	3.358***	2.949***	2.592***	2.147***
Obs. (Sub-indicators)	278	278	272	272	272	272
R^2	0.160	0.176	0.235	0.250	0.259	0.292
Adjusted R^2	0.101	0.116	0.168	0.164	0.156	0.165
Residual Std. Error	0.942	0.935	0.902	0.904	0.908	0.903
F Statistic	2.735***	2.910***	3.480***	2.894***	2.522***	2.310***

Notes: This table shows OLS estimates and 95% confidence intervals of the effects of institution strength on the Service Participation Index, a measure of the level of participation of citizens in *cargos* and *tequios*. The first row shows results from models in which *Institution Strength Index* was the predictor of interest. The panel below shows results from models in which the sub-indicators were included instead. *Communal Land* is the proportion of land within the municipality that is communally owned under the *comunidades agrarias* scheme. *Vote Requirements* is an index measuring the service obligations that citizens must meet in order to vote in Communal Assembly. *Cargo Ratio* is the ratio of total *cargo* positions in the community to adult male population. *Sanction Severity Index* is a measure of the severity of punishment for non-cooperators. *Basic Geographic* covariates are: latitude, longitude, mean annual temperature, and mean annual precipitation. *Geographic isolation* covariates are: altitude, Terrain Ruggedness Index, and distance to the nearest city, port, railroad, and highway. *Geographic wealth potential* covariates are: suitability for maize, sugarcane, coffee, and cacao, and distance to the nearest gold or silver mine. *Demographic* covariates are sex ratio, average educational attainment, employment rate, proportion of households with dirt floors, and proportion of the population the is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

*** p < 0.001, ** p <0.01, * p < 0.05, + p < 0.1

Table 3. Mobilizing cooperation: Migrant remittances for public works

	Migrants send remittances (logit)					
	(1)	(2)	(3)	(4)	(5)	(6)
Institution Index	1.345*	1.444*	1.328+	1.348+	1.314+	1.395*
	(1.05, 1.74)	(1.09, 1.94)	(0.99, 1.81)	(0.99, 1.85)	(0.96, 1.82)	(1.01, 1.96)
Communal Land	1.201	1.184	1.110	1.220	1.253	1.443+
	(0.91, 1.61)	(0.88, 1.61)	(0.81, 1.54)	(0.85, 1.76)	(0.86, 1.85)	(0.96, 2.19)
Vote Requirements	0.908	0.903	0.832	0.840	0.799	0.785
	(0.69, 1.19)	(0.69, 1.19)	(0.62, 1.11)	(0.62, 1.13)	(0.58, 1.09)	(0.57, 1.08)
Cargo Ratio	0.920	0.894	0.937	0.911	0.962	0.969
	(0.70, 1.20)	(0.64, 1.23)	(0.66, 1.31)	(0.64, 1.29)	(0.67, 1.39)	(0.66, 1.42)
Sanction Severity Index	1.446**	1.440*	1.398*	1.430*	1.382*	1.437*
	(1.10, 1.92)	(1.09, 1.92)	(1.05, 1.88)	(1.07, 1.94)	(1.02, 1.89)	(1.05, 1.99)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes	Yes
log(Population)	No	Yes	Yes	Yes	Yes	Yes
Basic Geographic	No	No	Yes	Yes	Yes	Yes
Geographic Isolation	No	No	No	Yes	Yes	Yes
Geo. Wealth Potential	No	No	No	No	Yes	Yes
Demographics	No	No	No	No	No	Yes
Obs. (Institution Index)	343	343	337	335	335	335
Log Likelihood	-216.139	-215.629	-209.085	-203.775	-203.296	-199.641
Akaike Inf. Crit.	464.278	465.258	460.170	461.550	470.592	479.283
Obs. (Sub-indicators)	270	270	264	264	264	264
Log Likelihood	-164.334	-164.283	-157.433	-153.398	-151.477	-146.536
Akaike Inf. Crit.	364.668	366.565	360.867	364.796	370.953	377.072

Notes: This table shows odds ratios estimates and 95% confidence intervals of the effects of institution strength on a dummy variable that equals one when migrants send remittances for public works projects. The first row shows results from models in which *Institution Strength Index* was the predictor of interest. The panel below shows results from models in which the sub-indicators were included instead. *Communal Land* is the proportion of land within the municipality that is communally owned under the *comunidades agrarias* scheme. *Vote Requirements* is an index measuring the service obligations that citizens must meet in order to vote in Communal Assembly. *Cargo Ratio* is the ratio of total *cargo* positions in the community to adult male population. *Sanction Severity Index* is a measure of the severity of punishment for non-cooperators. *Basic Geographic* covariates are: latitude, longitude, mean annual temperature, and mean annual precipitation. *Geographic isolation* covariates are: altitude, Terrain Ruggedness Index, and distance to the nearest city, port, railroad, and highway. *Geographic wealth potential* covariates are: suitability for maize, sugarcane, coffee, and cacao, and distance to the nearest gold or silver mine. *Demographic* covariates are sex ratio, average educational attainment, employment rate, proportion of households with dirt floors, and proportion of the population the is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

*** p < 0.001, ** p <0.01, * p < 0.05, + p < 0.1

Table 4. Mobilizing cooperation: Recent migrant contributions to public works

	Recent migrant contributions (logit)					
	(1)	(2)	(3)	(4)	(5)	(6)
Institution Index	1.270*	1.272+	1.184	1.235	1.260	1.323+
	(1.01, 1.60)	(0.98, 1.66)	(0.90, 1.57)	(0.93, 1.65)	(0.94, 1.70)	(0.98, 1.80)
Communal Land	1.210	1.170	1.128	1.369+	1.454*	1.550*
	(0.94, 1.6)	(0.90, 1.53)	(0.85, 1.50)	(0.99, 1.91)	(1.03, 2.08)	(1.08, 2.25)
Vote Requirements	1.112	1.094	1.018	0.980	0.955	0.979
	(0.87, 1.43)	(0.85, 1.41)	(0.78, 1.33)	(0.74, 1.29)	(0.72, 1.27)	(0.73, 1.31)
Cargo Ratio	1.042	0.950	1.018	0.933	0.974	1.045
	(0.81, 1.40)	(0.70, 1.34)	(0.74, 1.46)	(0.67, 1.35)	(0.70, 1.43)	(0.73, 1.56)
Sanction Severity Index	1.000	0.991	0.963	0.972	0.969	0.973
	(0.78, 1.29)	(0.77, 1.28)	(0.74, 1.25)	(0.75, 1.27)	(0.74, 1.27)	(0.74, 1.28)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes	Yes
log(Population)	No	Yes	Yes	Yes	Yes	Yes
Basic Geographic	No	No	Yes	Yes	Yes	Yes
Geographic Isolation	No	No	No	Yes	Yes	Yes
Geo. Wealth Potential	No	No	No	No	Yes	Yes
Demographics	No	No	No	No	No	Yes
Obs. (Institution Index)	376	376	366	364	364	364
Log Likelihood	-243.683	-243.683	-233.094	-226.881	-225.225	-222.170
Akaike Inf. Crit.	521.366	523.366	508.187	507.761	514.451	524.341
Obs. (Sub-indicators)	298	298	289	289	289	289
Log Likelihood	-193.378	-192.881	-183.522	-176.822	-175.010	-171.628
Akaike Inf. Crit.	424.755	425.762	413.044	411.645	418.021	427.256

Notes: This table shows odds ratios estimates and 95% confidence intervals of the effects of institution strength a dummy variable that equals 1 when migrants contributed to at least one public works project in prior four years. The first row shows results from models in which *Institution Strength Index* was the predictor of interest. The panel below shows results from models in which the sub-indicators were included instead. *Communal Land* is the proportion of land within the municipality that is communally owned under the *comunidades agrarias* scheme. *Vote Requirements* is an index measuring the service obligations that citizens must meet in order to vote in Communal Assembly. *Cargo Ratio* is the ratio of total *cargo* positions in the community to adult male population. *Sanction Severity Index* is a measure of the severity of punishment for non-cooperators. *Basic Geographic* covariates are: latitude, longitude, mean annual temperature, and mean annual precipitation. *Geographic isolation* covariates are: altitude, Terrain Ruggedness Index, and distance to the nearest city, port, railroad, and highway. *Geographic wealth potential* covariates are: suitability for maize, sugarcane, coffee, and cacao, and distance to the nearest gold or silver mine. *Demographic* covariates are sex ratio, average educational attainment, employment rate, proportion of households with dirt floors, and proportion of the population the is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

*** p < 0.001, ** p <0.01, * p < 0.05, + p < 0.1

owned are associated, respectively, with a 0.14 and a 0.19 standard deviation increase in the Service Participation Index (Sanction Severity Index: $\beta = 0.14[0.02, 0.30]$, $p < 0.05$; Communal land: $\beta = 0.19[0.026, 0.31]$, $p < 0.01$, Table 2, Column 1). Meanwhile, neither *Cargo* Ratio nor Voting Requirements Index is associated with Service Participation Index.

The likelihood that migrants send remittances for public works also increases with institution strength. A one standard deviation increase in Institution Strength Index is associated a 35% increase in likelihood that migrants send remittances (OR = 1.35[1.05, 1.74], $p < 0.05$, Table 3, Column1), an effect that stands up to the inclusion of covariates. Similarly, a one standard deviation increase in Institution Strength Index is associated with a 27% increase in likelihood that migrants have contributed to at least one public works project in the past four years (OR = 1.27[1.01, 1.60], $p < 0.05$, Table 4, Column 1), although the 95% confidence intervals on this estimate include 1 in some specifications. Among the sub-indicators, Sanction Severity Index has a large, robust association with migrant remittances for public works (OR = 1.45[1.10, 1.92], $p < 0.01$, (Table 3, Col. 1), while communal land tenure is associated with recent contributions (Table 4). The summarized results are visualized in Figure 7.

Exploratory analyses reveal that communities with stronger institutions may be more likely to *require* that migrants contribute to public works. A one standard deviation increase in Institution Strength Index is associated with 50% increase in likelihood that migrants are obliged to send remittances (OR = 1.5[1.07, 2.16], $p < 0.05$, Table B5, Column 1], although this estimate loses precision as covariates are added and the 95% confidence intervals include 0 in some specifications. Of the sub-indicators, only Voting Requirements Index predicts migrant contribution

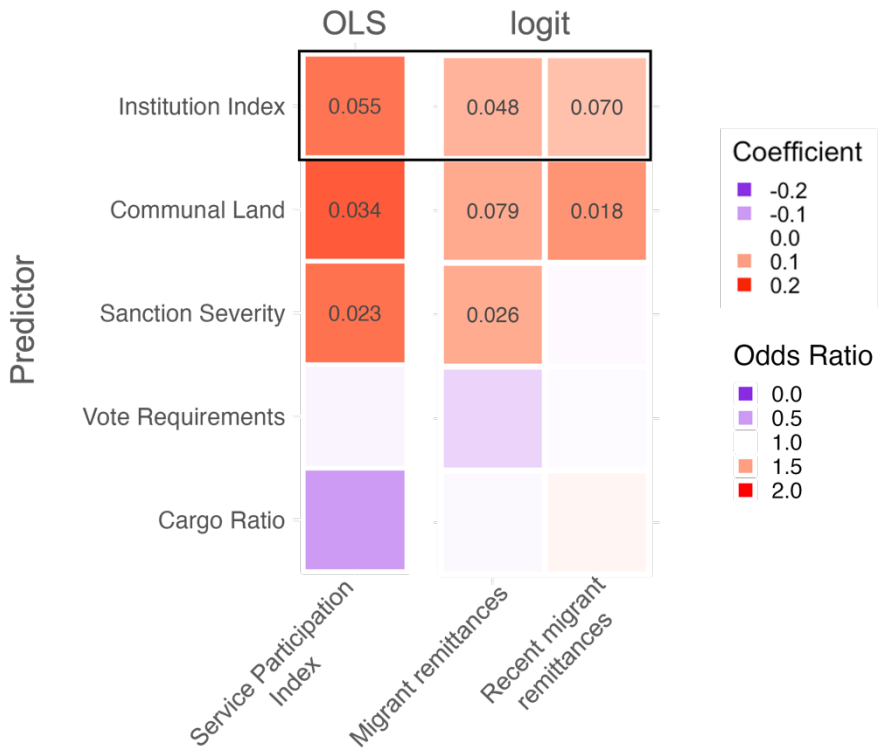

Figure 7. Relationship between institution strength and outcomes related to the community's ability to mobilize cooperation. The plot shows standardized OLS coefficients (left) and logistic regression odds ratios (right) from models that include all covariates. P-values below 0.10 are printed on the grid. The predictors of interest are shown on the y-axis, and the outcomes are on the x-axis. *Institution Index* averages across the four sub-indicators (*Communal land, Sanction Severity, Vote Requirements, and Cargo Ratio). Service Participation Index* captures the level of participation of citizens in *cargos* and *tequios*. *Migrant remittances* is a dummy variable that equals 1 when migrants send remittances for public works projects. *Recent migrant remittances* is a dummy variable that equals 1 when migrants have contributed to at least one public works project in the prior four years.

requirements– communities that require more participation from citizens in order to vote in assemblies are also much more likely to require migrants to send remittances for public works (OR = 2.0[1.22, 3.83], $p < 0.05$, Table B5, Column 1). Nonetheless, when a dummy variable for this requirement is included as a covariate in the main models, Sanction Severity Index still has a robust, positive effect on migrant contributions (OR = 1.4[1.08, 1.96], $p < 0.05$, Table B6, Column 1). Finally, exploratory analyses indicated that Sanction Severity Index was correlated with Migrant Sanction Severity Index, a measure of the severity of punishment for migrants who refuse to return to serve a *cargo* when required to do so ($r = 0.23$, $p < 0.05$).

Overall, these results suggest that communities with stronger *usos y costumbres* institutions mobilize more cooperation for the group benefit, including participation in *cargos* and *tequios* and migrant remittances for public works projects.

6.2 Public goods outcomes

In contrast, results regarding the relationship between institution strength and tangible public goods outcomes are mixed. While there is evidence of some relationships in the predicted direction, the effects are small and poorly estimated (Figure 8).

First, we examined the relationship between measures of institution strength and the provisioning of goods and services in the community, such as street cleaning and trash pickup. In

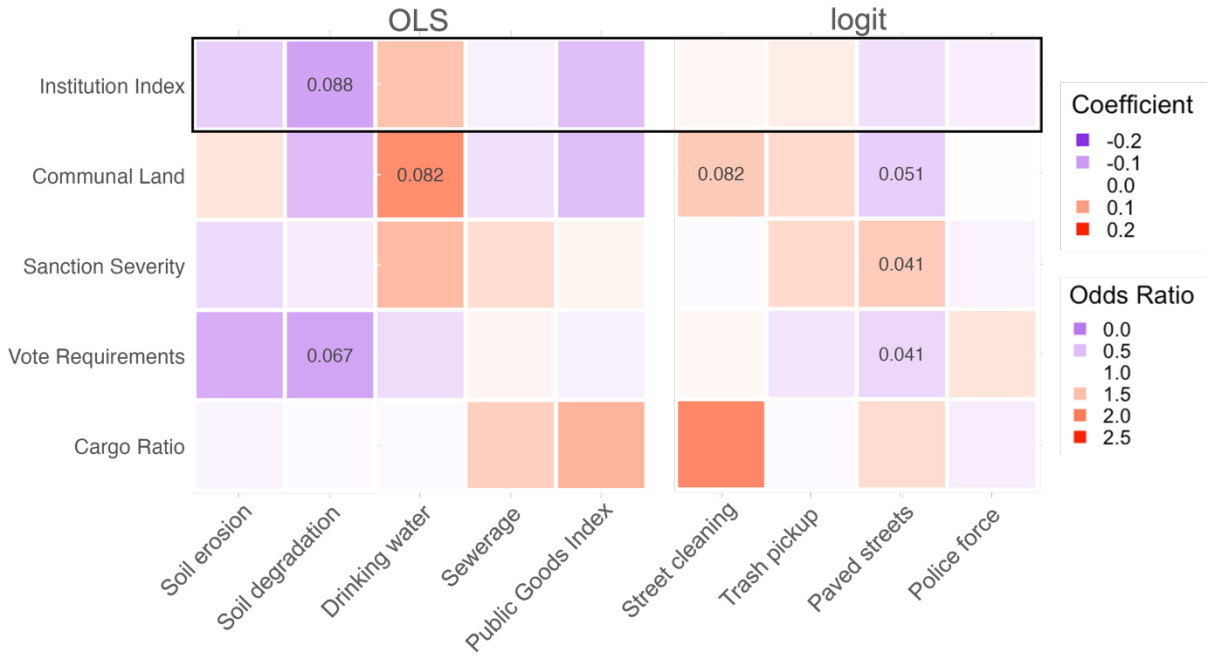

Figure 8. Relationship between institution strength and public goods outcomes. The plot shows standardized OLS coefficients (left) and logistic regression odds ratios (right) from models that include all covariates. P-values below 0.10 are printed on the grid. The predictors of interest are shown on the y-axis, and the outcomes are on the x-axis. *Institution Index* averages across the four sub-indicators (*Communal land, Sanction Severity, Vote Requirements, and Cargo Ratio). Soil erosion* and *Soil degradation* are measures of average erosion and degradation on municipality lands. *Drinking water* and *Sewerage* represent the proportion of households that have piped water and sewerage service, respectively. *Public Goods Index* averages across 10 dummy variables indicating the presence of various goods and services within the community. Dummies indicating the presence of the four goods and services with the most variation are show in the logit panel: *Street cleaning*, *Trash Pickup*, *Paved streets*, and *Police force*.

a basic model with no covariates, there is a negative relationship between Institution Strength Index and Public Goods Index (β = –0.13 [–0.25, –0.01], $p < 0.05$, Table B7, Column 1), suggesting that communities with stronger institutions provide *fewer* good and services. However, this effect shrinks when covariates are added (Table 5, Column 1; Figure 8). Focusing on goods and services that showed the most variation between *usos y costumbres* communities, we found no association between Institution Strength Index and the presence of street cleaning, trash pickup, street paving, or a police force (Table 5, Figure 8). Breaking the Institution Strength Index down into its sub-indicators, results show that communities with more communally held land are more likely to have street cleaning (OR = 1.41[0.96, 2.10], $p = 0.082$, Table 5, Column 2), but less likely to have paved streets (OR = 0.64[0.40, 0.99], $p = 0.05$, Table 5, Column 4). Communities with more voting requirements are also less likely to have paved streets (OR = 0.70[0.49, 0.98], $p < 0.05$, Table 5, Column 4). At the same time, a one standard deviation increase in Sanction Severity Index is associated in a 40% increase in the likelihood that the community has paved streets (OR = 1.41[1.02, 1.96], $p < 0.05$, Table 5, Column 4).

Results regarding the provisioning of piped water or sewerage service are similarly mixed. There is some evidence of an association between institution strength and the proportion of household with piped water. More communal land tenure is associated with a better provisioning of piped water (β = 0.28[0.17, 0.40], $p < 0.001$, Table 6, Column 1). As covariates are added, this coefficient remains sizable, although it shrinks somewhat. With all covariates included, results suggest that a one standard deviation increase in proportion of land that is communally held is associated with a 0.12 standard deviation increase in proportion of households with piped water (β = 0.12[-0.01, 0.24], $p = 0.08$, Table 6, Column 6) .The coefficients on Institution Strength

Table 5. Presence of public goods and services

	Public Goods Index (1)	Street Cleaning (2)	Trash Pickup (3)	Paved Streets (4)	Police Force (5)
Institution Index	-0.063	1.063	1.135	0.772	0.879
	(-0.20, 0.08)	(0.74, 1.52)	(0.75, 1.73)	(0.53, 1.11)	(0.62, 1.25)
Communal Land	-0.063	1.414^{+}	1.291	0.639^{+}	1.010
	(-0.21, 0.09)	(0.96, 2.10)	(0.82, 2.04)	(0.40, 0.99)	(0.70, 1.47)
Vote Requirements	-0.014	1.054	0.807	0.696*	1.208
	(-0.14, 0.11)	(0.77, 1.44)	(0.55, 1.18)	(0.49, 0.98)	(0.89, 1.66)
Cargo Ratio	0.078	1.908	0.967	1.277	0.866
	(-0.23, 0.38)	(0.88, 4.27)	(0.38, 2.30)	(0.57, 2.82)	(0.37, 1.97)
Sanction Severity Index	0.011	0.973	1.288	1.406*	0.914
	(-0.12, 0.13)	(0.71, 1.33)	(0.91, 1.85)	(1.02, 1.96)	(0.68, 1.23)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes
log(Population)	Yes	Yes	Yes	Yes	Yes
Basic Geographic	Yes	Yes	Yes	Yes	Yes
Geographic Isolation	Yes	Yes	Yes	Yes	Yes
Geo. Wealth Potential	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes
Observations (Index)	340	360	278	354	358
Adjusted R^2	0.035				
F Statistic	1.822*				
Log Likelihood		-187.934	-142.544	-187.177	-199.141
AIC		455.868	365.088	454.354	478.281
Observations (Sub-indicators)	270	285	278	279	283
Adjusted R^2	0.034				
F Statistic	1.520^{+}				
Log Likelihood		-141.844	-110.498	-135.007	-155.819
AIC		369.688	306.995	356.015	397.638

Notes: This table shows coefficients (Column 1) and odds ratios (Columns 2-5) and 95% confidence intervals of the effects of institution strength on the presence of various goods and services in the community. *Public Goods Index* (Column 1, OLS) is a continuous index that averages across dummies indicating the presence of: street cleaning, trash pickup, street lighting, paved street, a drinking water network, a community well, a cemetery, a jail, a basketball court, and a library. Columns 2-5 (logit) contain results for several specific goods and services. The first row shows results from models in which *Institution Strength Index* was the predictor of interest. The panel below shows results from models in which the sub-indicators were included instead. *Communal Land* is the proportion of land within the municipality that is communally owned under the *comunidades agrarias* scheme. *Vote Requirements* is an index

Table 5. Presence of public goods and services *(continued)*

measuring the service obligations that citizens must meet in order to vote in Communal Assembly. *Cargo Ratio* is the ratio of total *cargo* positions in the community to adult male population. *Sanction Severity Index* is a measure of the severity of punishment for non-cooperators. *Basic Geographic* covariates are: latitude, longitude, mean annual temperature, and mean annual precipitation. *Geographic isolation* covariates are: altitude, Terrain Ruggedness Index, and distance to the nearest city, port, railroad, and highway. *Geographic wealth potential* covariates are: suitability for maize, sugarcane, coffee, and cacao, and distance to the nearest gold or silver mine. *Demographic* covariates are sex ratio, average educational attainment, employment rate, proportion of households with dirt floors, and proportion of the population the is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table 6. Proportion of household with piped water

	Proportion of households with piped water					
	(1)	(2)	(3)	(4)	(5)	(6)
Institution Index	0.211***	0.172**	0.088	0.049	0.043	0.062
	(0.11, 0.31)	(0.06, 0.29)	(-0.03, 0.21)	(-0.06, 0.16)	(-0.07, 0.16)	(-0.05, 0.17)
Communal Land	0.283***	0.253***	0.199**	0.163*	0.146*	0.115+
	(0.17, 0.40)	(0.14, 0.37)	(0.08, 0.32)	(0.04, 0.29)	(0.02, 0.28)	(-0.01, 0.24)
Vote Requirements	-0.002	-0.015	-0.044	-0.034	-0.049	-0.035
	(-0.11, 0.10)	(-0.12, 0.09)	(-0.15, 0.06)	(-0.14, 0.07)	(-0.15, 0.06)	(-0.14, 0.07)
Cargo Ratio	0.010	-0.070	-0.080	-0.033	-0.056	-0.004
	(-0.10, 0.12)	(-0.21, 0.07)	(-0.22, 0.06)	(-0.17, 0.10)	(-0.19, 0.08)	(-0.14, 0.13)
Sanction Severity Index	0.071	0.062	0.047	0.040	0.065	0.071
	(-0.04, 0.18)	(-0.05, 0.17)	(-0.06, 0.15)	(-0.06, 0.14)	(-0.04, 0.17)	(-0.03, 0.17)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes	Yes
log(Population)	No	Yes	Yes	Yes	Yes	Yes
Basic Geographic	No	No	Yes	Yes	Yes	Yes
Geographic Isolation	No	No	No	Yes	Yes	Yes
Geo. Wealth Potential	No	No	No	No	Yes	Yes
Demographics	No	No	No	No	No	Yes
Obs. (Institution Index)	418	418	408	406	406	406
R^2	0.090	0.094	0.167	0.258	0.282	0.347
Adjusted R^2	0.054	0.056	0.123	0.207	0.222	0.277
Residual Std. Error	0.973	0.972	0.943	0.886	0.878	0.846
F Statistic	2.479**	2.446**	3.867***	5.066***	4.733***	4.981***
Obs. (Sub-indicators)	328	328	319	319	319	319
R^2	0.146	0.156	0.206	0.271	0.303	0.360
Adjusted R^2	0.093	0.101	0.144	0.198	0.219	0.262
Residual Std. Error	0.934	0.930	0.913	0.884	0.873	0.848
F Statistic	2.762***	2.843***	3.335***	3.710***	3.627***	3.694***

Notes: This table shows OLS estimates and 95% confidence intervals of the effects of institution strength on the the proportion of households with piped water. The first row shows results from models in which *Institution Strength Index* was the predictor of interest. The panel below shows results from models in which the sub-indicators were included instead. *Communal Land* is the proportion of land within the municipality that is communally owned under the *comunidades agrarias* scheme. *Vote Requirements* is an index measuring the service obligations that citizens must meet in order to vote in Communal Assembly. *Cargo Ratio* is the ratio of total *cargo* positions in the community to adult male population. *Sanction Severity Index* is a measure of the severity of punishment for non-cooperators. *Basic Geographic* covariates are: latitude, longitude, mean annual temperature, and mean annual precipitation. *Geographic isolation* covariates are: altitude, Terrain Ruggedness Index, and distance to the nearest city, port, railroad, and highway. *Geographic wealth potential* covariates are: suitability for maize, sugarcane, coffee, and cacao, and distance to the nearest gold or silver mine. *Demographic* covariates are sex ratio, average educational attainment, employment rate, proportion of households with dirt floors, and proportion of the population the is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

*** p < 0.001, ** p <0.01, * p < 0.05, + p < 0.1

Table 7. Proportion of household with sewerage service

	Proportion of households with sewerage service					
	(1)	(2)	(3)	(4)	(5)	(6)
Institution Index	-0.043	0.010	-0.022	-0.036	-0.046	-0.015
	(-0.14, 0.06)	(-0.11, 0.13)	(-0.14, 0.09)	(-0.15, 0.07)	(-0.16, 0.07)	(-0.12, 0.09)
Communal Land	0.011	0.019	-0.008	0.018	-0.011	-0.030
	(-0.11, 0.13)	(-0.10, 0.14)	(-0.13, 0.11)	(-0.11, 0.14)	(-0.14, 0.12)	(-0.16, 0.10)
Vote Requirements	-0.016	-0.013	-0.016	-0.010	-0.017	0.009
	(-0.13, 0.10)	(-0.13, 0.09)	(-0.12, 0.09)	(-0.11, 0.09)	(-0.12, 0.09)	(-0.09, 0.11)
Cargo Ratio	-0.072	-0.050	-0.036	-0.012	-0.038	0.049
	(-0.19, 0.05)	(-0.19, 0.10)	(-0.18, 0.10)	(-0.15, 0.13)	(-0.18, 0.10)	(-0.09, 0.18)
Sanction Severity Index	0.041	0.043	0.031	0.012	0.030	0.035
	(-0.07, 0.15)	(-0.07, 0.16)	(-0.08, 0.14)	(-0.09, 0.12)	(-0.08, 0.14)	(-0.06, 0.13)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes	Yes
log(Population)	No	Yes	Yes	Yes	Yes	Yes
Basic Geographic	No	No	Yes	Yes	Yes	Yes
Geographic Isolation	No	No	No	Yes	Yes	Yes
Geo. Wealth Potential	No	No	No	No	Yes	Yes
Demographics	No	No	No	No	No	Yes
Obs. (Institution Index)	418	418	408	406	406	406
R^2	0.081	0.089	0.225	0.307	0.327	0.410
Adjusted R^2	0.045	0.050	0.185	0.260	0.271	0.347
Residual Std. Error	0.977	0.975	0.904	0.859	0.853	0.807
F Statistic	2.223**	2.294**	5.632***	6.464***	5.849***	6.513***
Obs. (Sub-indicators)	328	328	319	319	319	319
R^2	0.083	0.084	0.219	0.290	0.306	0.409
Adjusted R^2	0.026	0.024	0.159	0.219	0.222	0.319
Residual Std. Error	0.984	0.985	0.917	0.883	0.881	0.825
F Statistic	1.464+	1.401	3.605***	4.077***	3.674***	4.553***

Notes: This table shows OLS estimates and 95% confidence intervals of the effects of institution strength on the proportion of households with sewerage service. The first row shows results from models in which *Institution Strength Index* was the predictor of interest. The panel below shows results from models in which the sub-indicators were included instead. *Communal Land* is the proportion of land within the municipality that is communally owned under the *comunidades agrarias* scheme. *Vote Requirements* is an index measuring the service obligations that citizens must meet in order to vote in Communal Assembly. *Cargo Ratio* is the ratio of total *cargo* positions in the community to adult male population. *Sanction Severity Index* is a measure of the severity of punishment for non-cooperators. *Basic Geographic* covariates are: latitude, longitude, mean annual temperature, and mean annual precipitation. *Geographic isolation* covariates are: altitude, Terrain Ruggedness Index, and distance to the nearest city, port, railroad, and highway. *Geographic wealth potential* covariates are: suitability for maize, sugarcane, coffee, and cacao, and distance to the nearest gold or silver mine. *Demographic* covariates are sex ratio, average educational attainment, employment rate, proportion of households with dirt floors, and proportion of the population the is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

*** p < 0.001, ** p <0.01, * p < 0.05, + p < 0.1

Table 8. Degree of soil erosion and degradation

	Soil Erosion			Soil Degradation		
	(1)	(2)	(3)	(4)	(5)	(6)
Institution Index	-0.087^{+}	-0.059	-0.048	-0.205***	-0.101^{+}	-0.090^{+}
	(-0.18, 0.01)	(-0.17, 0.06)	(-0.16, 0.07)	(-0.30, -0.11)	(-0.20, 0.00)	(-0.19, 0.01)
Communal Land	-0.129*	0.007	0.027	-0.307***	-0.059	-0.066
	(-0.24, -0.02)	(-0.12, 0.14)	(-0.11, 0.16)	(-0.42, -0.13)	(-0.18, 0.06)	(-0.19, 0.05)
Vote Requirements	-0.073	-0.067	-0.080	-0.072	-0.076	-0.089^{+}
	(-0.18, 0.03)	(-0.17, 0.04)	(-0.19, 0.03)	(-0.18, 0.04)	(-0.17, 0.09)	(-0.18, 0.01)
Cargo Ratio	0.058	-0.001	-0.011	0.009	-0.035	-0.004
	(-0.06, 0.17)	(-0.14, 0.14)	(-0.15, 0.13)	(-0.11, 0.12)	(-0.16, 0.09)	(-0.13, 0.12)
Sanction Severity Index	-0.031	-0.041	-0.036	-0.017	-0.029	-0.019
	(-0.14, 0.08)	(-0.15, 0.06)	(-0.14, 0.07)	(-0.13, 0.09)	(-0.12, 0.06)	(-0.11, 0.08)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes	Yes
log(Population)	No	Yes	Yes	No	Yes	Yes
Basic Geographic	No	Yes	Yes	No	Yes	Yes
Geographic Isolation	No	Yes	Yes	No	Yes	Yes
Geo. Wealth Potential	No	Yes	Yes	No	Yes	Yes
Demographics	No	No	Yes	No	No	Yes
Obs. (Institution Index)	418	406	406	418	406	406
R^2	0.153	0.281	0.303	0.111	0.420	0.432
Adjusted R^2	0.119	0.221	0.228	0.075	0.372	0.371
Residual Std. Error	0.939	0.885	0.881	0.962	0.791	0.792
F Statistic	4.517***	4.713***	4.075***	3.116***	8.726***	7.127***
Obs. (Sub-indicators)	328	319	319	328	319	319
R^2	0.155	0.310	0.333	0.160	0.465	0.484
Adjusted R^2	0.103	0.228	0.232	0.108	0.401	0.406
Residual Std. Error	0.947	0.880	0.878	0.957	0.781	0.778
F Statistic	2.971***	3.761***	3.282***	3.083***	7.268***	6.165***

Notes: This table shows OLS estimates and 95% confidence intervals of the effects of institution on the average level of soil erosion (columns 1-3) and soil degradation (columns 4-6) on municipal lands. The first row shows results from models in which *Institution Strength Index* was the predictor of interest. The panel below shows results from models in which the sub-indicators were included instead. *Communal Land* is the proportion of land within the municipality that is communally owned under the *comunidades agrarias* scheme. *Vote Requirements* is an index measuring the service obligations that citizens must meet in order to vote in Communal Assembly. *Cargo Ratio* is the ratio of total *cargo* positions in the community to adult male population. *Sanction Severity Index* is a measure of the severity of punishment for non-cooperators. *Basic Geographic* covariates are: latitude, longitude, mean annual temperature, and mean annual precipitation. *Geographic isolation* covariates are: altitude, Terrain Ruggedness Index, and distance to the nearest city, port, railroad, and highway. *Geographic wealth potential* covariates are: suitability for maize, sugarcane, coffee, and cacao, and distance to the nearest gold or silver mine. *Demographic* covariates are sex ratio, average educational attainment, employment rate, proportion of households with dirt floors, and proportion of the population the is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

*** p < 0.001, ** p <0.01, * p < 0.05, + p < 0.1

Table 9. Wildfire size (hectares)

	Log(Area burned)				
	(1)	(2)	(3)	(4)	(5)
Institution Index	1.092	0.973	0.945	0.989	1.013
	(0.84, 1.42)	(0.74, 1.28)	(0.72, 1.24)	(0.76, 1.27)	(0.77, 1.29)
Communal Land	1.212	1.140	0.983	1.016	1.074
	(0.90, 1.67)	(0.86, 1.55)	(0.74, 1.35)	(0.79, 1.36)	(0.83, 1.45)
Vote Requirements	0.994	0.940	0.959	1.073	1.153
	(0.74, 1.32)	(0.70, 1.22)	(0.73, 1.22)	(0.82, 1.28)	(0.87, 1.41)
Cargo Ratio	0.989	0.298*	0.226**	0.272*	0.293*
	(0.45, 2.28)	(0.108, 0.82)	(0.08, 0.60)	(0.09, 0.65)	(0.11, 0.77)
Sanction Severity Index	0.949	0.911	0.925	0.874	0.948
	(0.70, 1.28)	(0.68, 1.19)	(0.70, 1.19)	(0.66, 1.05)	(0.71, 1.17)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes
log(Population)	No	Yes	Yes	Yes	Yes
Fire Covariates	No	No	Yes	Yes	Yes
Basic Geographic	No	No	No	Yes	Yes
Demographics	No	No	No	No	Yes
Institution Index Models					
N (fires)	372	372	370	339	339
Community Std. Dev.	1.03	0.97	0.91	0.72	0.68
Ethnolinguistic Std. Dev.	0.40	0.33	0.35	0.57	0.45
Log Likelihood	1,484.964	1,483.872	1,465.361	1,395.112	1,378.970
AIC	1,504.558	1,507.385	1,555.372	1,506.066	1,512.880
Sub-indicator Models					
N (fires)	286	286	286	256	256
Community Std. Dev.	1.02	0.88	0.82	0.57	0.60
Ethnolinguistic Std. Dev.	0.40	0.26	0.21	0.49	0.36
Log Likelihood	1,162.573	1,154.762	1,153.194	1,097.949	1,076.339
AIC	1,191.821	1,187.665	1,248.249	1,211.395	1,211.056

Notes: This table shows exponentiated LMER estimates and 95% confidence intervals of the effects of institution strength on the area burned during wildfires. Models include random intercepts for communities nested within ethnolinguistic groups. The first row shows results from models in which *Institution Strength Index* was the predictor of interest. The panel below shows results from models in which the sub-indicators were included instead. Models include random intercepts for communities nested in ethnolinguistic groups. *Communal Land* is the proportion of land within the municipality that is communally owned under the *comunidades agrarias* scheme. *Vote Requirements* is an index measuring the service obligations that citizens must meet in order to vote in Communal Assembly. *Cargo Ratio* is the ratio of total *cargo* positions in the community to adult male population. *Sanction Severity Index* is a measure of the severity of punishment for non-cooperators. *Fire Covariates* are: average geo-climatic fire risk within municipality, fire year, fire month, and distance of fire from community. *Basic Geographic* covariates are latitude, longitude, altitude, mean annual temperature, mean annual precipitation, Terrain Ruggedness Index, and distance from the highway. *Demographic* covariates are: sex ratio, employment rate, proportion of households with dirt floors, and proportion of the population the is under age 12 and over age 60.

*** p < 0.001, ** p <0.01, * p < 0.05, + p < 0.1

Index and Sanction Severity Index are also positive, but the confidence intervals include 0 in most specifications (Figure 8, Table 6). There is no evidence that sewerage service is associated with institution strength (Table 7).

Results tentatively suggest that communities with stronger institutions may have healthier soil. The coefficients on most measures of institution strength are negative when predicting the degree of soil erosion; however, the coefficients are small, and the confidence intervals include 0 (Table 8, Columns 1-3). Our exploratory analysis of all type of soil degradation yielded slightly stronger evidence of a negative association between institution strength and soil health. Once again, the coefficients on most measures of institution strength are negative (Table 8, Columns 4-6). For example, a one standard deviation increase in Institution Index is associated with a 0.21 standard deviation decline in soil degradation ($\beta = -0.21$ [–0.30, –0.11], $p < 0.001$, Table 8 Column 4). However, this coefficient loses size as covariates are added and the confidence intervals include 0 in some specifications.

Finally, our analysis of wildfires yielded mostly nulls results. Institution Strength Index, communal land tenure, voting requirements, and Sanction Severity Index are not associated with the area burned during fires (Table 9). However, there is some evidence that communities with a higher *Cargo* Ratio may have smaller fires. When fire-specific controls, ethnolinguistic fixed effects, and a basic set of geographic and demographic controls are included, a one standard deviation increase in *Cargo* Ratio is associated with a 71% decrease in hectares burned (exponentiated $\beta = 0.29$[0.11, 0.77], $p < 0.05$, Table 9, Column 5).

6.3 Population size as a moderating factor

Exploratory analyses revealed that the relationship between institution strength and outcomes is moderated by population size in some cases. There are significant, positive interactions between Institutions Strength Index and total population size on measures of the community's ability to mobilize cooperation. As visualized in Figure 9, Service Participation Index increases with Institution Strength Index in larger towns, but not small ones (interaction term $\beta = 0.14[0.05, 0.23]$, $p < 0.01$, Table B8, Column 1). Similarly, Figure 10 shows the positive interaction between Institution Strength Index and total population on the probability of migrant remittances for public works (OR = 1.31[1.1, 1.7], $p < 0.05$, Table B8, Column 2) and of recent migrant remittances (OR = 1.28[1.1, 1.5], $p < 0.05$, Table B8, Column 3). The probability of migrant

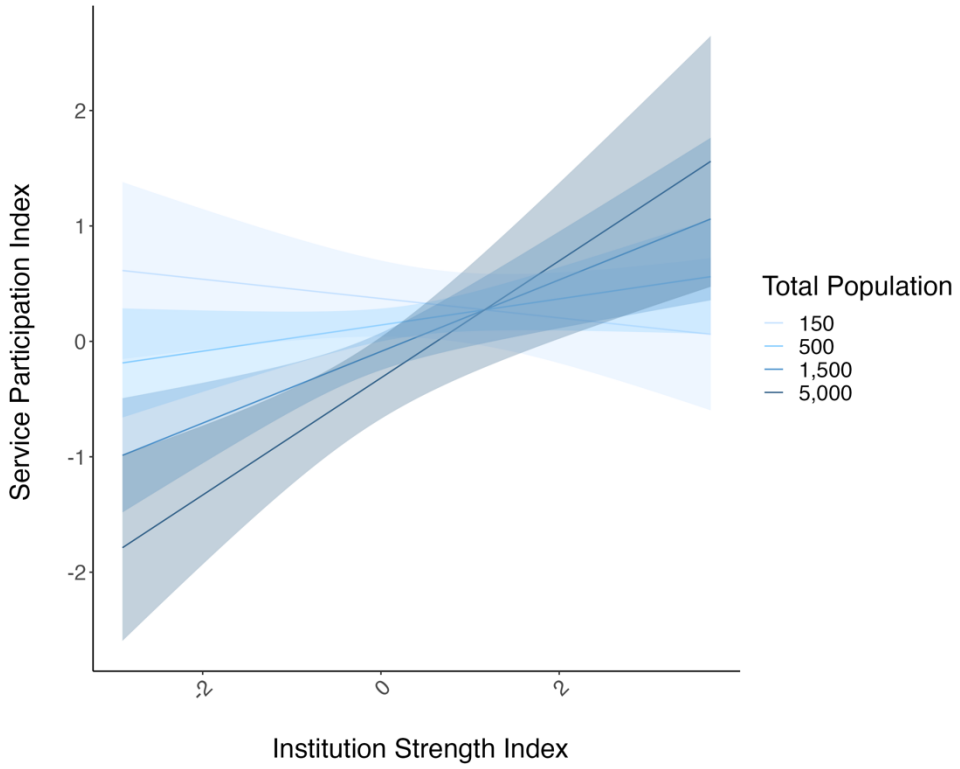

Figure 9. Participation in *cargos* and *tequios* increases with Institution Strength Index in larger populations. This plot shows estimated effect of Institution Strength Index on Service Participation Index for communities with different population sizes.

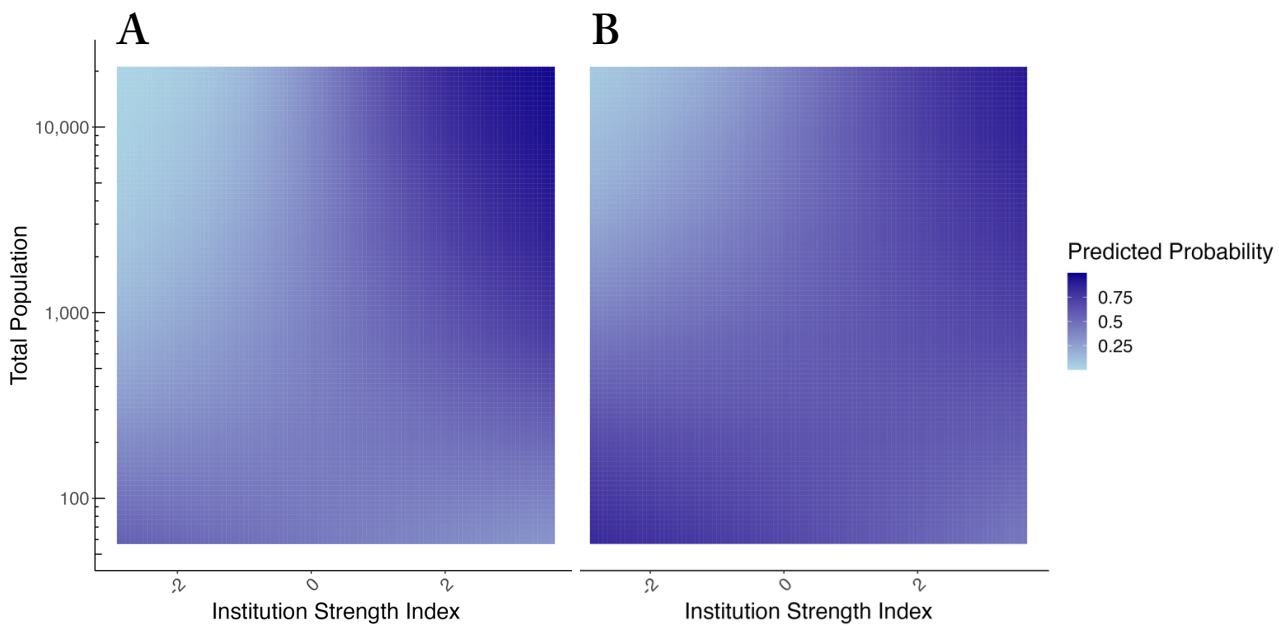

Figure 10. Predicted probability that migrants contribute public works (A) and that they've contributed within the past 4 years (B) by total population and Institution Strength Index. This heatmap shows predicted probabilities of migrant economic cooperation based on the interaction of total population and Institution Strength Index.

economic cooperation increases with Institution Strength Index in large towns, but may instead decline slightly with Institution Strength Index in very small towns.

In contrast, there is little evidence that population size modulates the effect of institution strength on tangible public goods outcomes. There is no interaction between Institution Strength Index and population size on proportion of houses with piped water, proportion of houses with sewerage service, soil erosion, soil degradation, or wildfire size (Table B9). However, there may be a negative interaction between Institution Strength Index and population size on Public Goods Index (with all covariates, $\beta = -0.13[-0.28, 0.01]$, $p = 0.08$, Table B9, Column 1). While this coefficient is small and imprecisely estimated, Figure 11 suggests that the provisioning of these public goods may decline with institution strength in very large, but not smaller, populations.

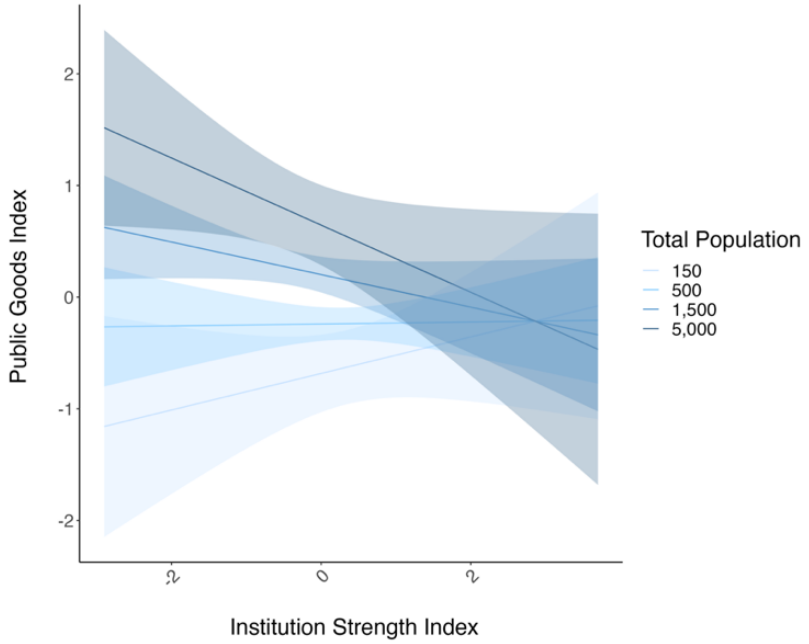

Figure 11. Public Goods Index trends in decline with increasing institution strength in large population. These plots show estimated effects of Institution Strength Index on Public Goods Index for communities with different population sizes.

Finally, exploratory analyses indicate that smaller communities have stronger institutions. Population size is a robust negative predictor of Institution Strength Index ($\beta = -0.16[-0.30, -0.03]$, $p < 0.05$, Table 10, Column 1), Sanction Severity Index ($\beta = -0.20[-0.36, -0.04]$, $p < 0.05$, Table 10, Column 2), and perhaps Voter Requirements Index ($\beta = -0.15[-0.31, 0.006]$, $p = 0.06$, Table 10, Column 5). These results hold even when the largest communities are excluded, analyzing the subset of 380 communities that are below a total population of 3,000.

7. Discussion

Our results offer strong support for the hypothesis that indigenous Oaxacan communities with stronger traditional political institutions mobilize more cooperation. Leaders of communities with stronger institutions reported a higher level of citizen participation in *cargos* and *tequios*, suggesting that these communities harness more labor for the group benefit. Moreover, as

Table 10. Institution strength varies with populations size

	Institution Index	Sanction Severity Index	Communal Land	*Cargo* Ratio	Voter Requirements
	(1)	(2)	(3)	(4)	(5)
Log(Total Population)	-0.16*	-0.20*	0.02	-0.90***	-0.15+
	(-0.30, -0.03)	(-0.36, -0.04)	(-0.11, 0.15)	(-1.04, -0.77)	(-0.31, 0.01)
Ethnolinguistic FEs	Yes	Yes	Yes	Yes	Yes
log(Population)	Yes	Yes	Yes	Yes	Yes
Fire Covariates	Yes	Yes	Yes	Yes	Yes
Basic Geographic	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes
Institution Index Models					
Obs. (Institution Index)	406	406	385	340	403
R^2	0.353	0.148	0.451	0.565	0.175
Adjusted R^2	0.286	0.060	0.391	0.511	0.089
Residual Std. Error	0.838	0.964	0.775	0.705	0.939
F Statistic	5.261***	1.677**	7.486***	10.308***	2.036***

Notes: This table shows OLS estimates and 95% confidence intervals of the effects of population size on measures of institution strength. *Institution Index* (Column 1) averages across Sanction Severity Index, Communal Land, and Voter Requirements. *Cargo* Ratio was excluded from the Index because it is mechanically linked to population size (which is reflected in the results in Column 4). *Basic Geographic* covariates are: latitude, longitude, mean annual temperature, and mean annual precipitation. *Geographic isolation* covariates are: altitude, Terrain Ruggedness Index, and distance to the nearest city, port, railroad, and highway. *Geographic wealth potential* covariates are: suitability for maize, sugarcane, coffee, and cacao, and distance to the nearest gold or silver mine. *Demographic* covariates are sex ratio, average educational attainment, employment rate, proportion of households with dirt floors, and proportion of the population the is: under age 12, over age 60, Catholic, and a speaker of an indigenous language.

*** p < 0.001, ** p <0.01, * p < 0.05, + p < 0.1

institution strength increases, so does the likelihood that migrants send remittances for public works projects, demonstrating that these communities extract greater cooperation from citizens living and working elsewhere. Together, these results provide support for the cultural evolutionary theory that institutions shape human cooperation, contributing to broad cross-cultural variation (Muthukrishna & Henrich, 2021; Henrich 2020).

However, we found limited support for the hypothesis that communities with stronger traditional political institutions provide more public goods. While there is evidence that some measures of institution strength predict some public goods outcomes, these effects are generally small, imprecisely estimated, or both. No consistent pattern emerged. Thus, while communities with stronger institutions mobilize more cooperation, this does not appear to translate into tangible public goods outcomes.

Our analyses offer several clues regarding the mechanisms through which Oaxacan traditional political institutions may enhance cooperation. First, in line with predictions from formal evolutionary models (Boyd et al., 2010; Henrich & Boyd, 2001; Jordan et al., 2016; Noblit & Henrich, 2023), punishment appears to play an important role in stabilizing cooperation within Oaxacan *usos y costumbres* communities. The Sanction Severity Index, which quantifies the severity of punishment for cooperation-related violations such as skipping *tequio* and refusing a *cargo*, strongly predicts the level of participation in *cargos* and *tequios*. This suggests that punishment may motivate citizens to fulfill their duties of service to the community, a result which echoes our recent ethnographic work in a Zapotec community run under *usos y costumbres* (Curtin et al., 2024). The likelihood that migrants send remittances for public works also increases with Sanction Severity Index. Since the Sanction Severity Index does not include information about punishments specifically against uncooperative migrants, the interpretation of this relationship is less

straightforward. It is possible that communities that sanction defectors locally are also more likely to sanction uncooperative migrants. To explore this possibility, we tested whether the Sanction Severity Index predicts the severity of punishment for migrants who refuse to return to serve a *cargo* when the community requires them to do so. In the small sample of 104 communities for which these data were available, there was a positive correlation between these punishment measures. This suggests that communities that levy harsh sanctions locally may also use punishment to stabilize migrant cooperation. However, as noted by Danielson (2013), in many communities, migrants contribute to public works projects even when they are not required to do so. Thus, a second, complementary explanation is that harsher sanctions reflect stronger norms about community cooperation. Migrants who have internalized strong norms about supporting their community may be more intrinsically motivated to send remittances for public works. Offering tentative support for this interpretation, the effect of Sanction Severity Index on migrant contributions holds up when controlling for a dummy variable indicating whether contributions are required. At the very least, this indicates that the effect of Sanction Severity Index on migrant remittances is not entirely driven by requirements about participation (and possible associated sanctions).

We also found compelling evidence that communal land tenure is associated with community cooperation. As the proportion of land that is communally owned increases, so does (1) the level of participation in *cargos* and *tequios* and (2) the likelihood that migrants send remittances for public works. Because communal control of resources can build interdependence within groups (Cronk, Steklis, et al., 2019; Harris & Honig, 2023; Henrich, 2020), these results are consistent with a role for interdependence psychology in cooperation within *usos y costumbres* communities. Recent work in economic history offers a complementary interpretation: communal

land tenure itself may reflect the historical strength of indigenous institutions. Contemporary patterns of communal land tenure in Mexico reflect the ability of communities to legally repossess their ancestral lands through the creation of *comunidades agrarias* (agrarian communities). During the 20th century, Mexico went through a period of massive land redistribution. To legally repossess their lands, communities had to collectively petition the government and provide proof of ancestral possession, often by furnishing a primordial title granted by the Spanish Crown during the Colonial period (Elizalde, 2020). In a recent study, Elizalde (2020) examined the role of historical indigenous political complexity (jurisdictional hierarchy) on 20th-century land redistribution in Mexico. He found that indigenous communities from ethnolinguistic groups with greater historical political complexity were more successful in legally repossessing their ancestral lands. Elizalde (2020) argues that this reflects the persistence of historical indigenous institutions, which facilitated greater cohesion and collective action in petitioning the government. Thus, in addition to directly building cooperation through interdependence today, it is possible that contemporary communal land tenure reflects deep, historical features of indigenous Oaxacan institutions that facilitate collective action.

Finally, exploratory analyses revealed that the effects of institution strength on the community's ability to mobilize cooperation varies with population size. We found that stronger traditional political institutions are associated with greater cooperation in large, but not small, communities. Moreover, analyses indicated that small communities are more effective than large communities at mobilizing cooperation in the absence of strong institutions (see Figures 3.9 & 3.10). This suggests that other mechanisms may be sufficient to sustain cooperation in very small populations, such as genetic kinship, reciprocity, and fitness interdependence associated with life in a tightly knit community. These forces are less effective at stabilizing cooperation in large

populations (e.g. reciprocity, see Boyd & Richerson, 1988). This suggests that, as groups expand in size, institutions that can stabilize cooperation at larger scales may culturally evolve. At the same time, we also found that larger Oaxacan communities tend to have weaker traditional political institutions, including less harsh sanctions and fewer voting requirements. So, while stronger institutions may offer greater cooperative benefits to larger communities, these communities are less likely to actually *have* such institutions. Future research should investigate this dynamic. For example, perhaps strong *usos y costumbres* institutions degrade in large communities as competitive intergroup pressures weaken.

This study has several limitations. First, although we included a rich set of covariates in the models, our data are correlational. Therefore, we cannot establish whether institution strength plays a causal role in cooperation within Oaxacan communities. Second, several of our measures are based on self-report data from a survey of top *cargo*-holders (2008 Survey of Oaxaca, Mexico Customary Law Municipalities, Danielson, 2013; Polo & Danielson, 2013). For example, the Service Participation Index is based on a series of questions that asked the *cargo*-holders to report, in their opinion, the level of citizen participation in various activities. If *cargo*-holders in communities with stronger institutions were more motivated to represent their community as cooperative in this survey, this would introduce bias in the data. Future research should work to establish whether the relationships uncovered in this study are causal.

This study suggests rich potential for future research. First, we should investigate the curious null effects on public goods outcomes. If stronger traditional political institutions enhance cooperation within Oaxacan communities, why does this not cash out in terms of tangible public goods? Future work should investigate whether a community's success in negotiating with the state (e.g. ability to obtain state funding) is impacted by the strength of their traditional political

institutions, and if so, whether this influences public goods outcomes. Uncovering the reason for the lack of association between institution strength and public goods outcomes will be an important step towards understanding how traditional political institutions impact economic development.

Second, while our data offer clues about the possible mechanisms through which these Oaxacan traditional political institutions stabilize cooperation, future research should dig deeper. Our recent ethnographic and psychological research within one Zapotec community points to several social and psychological mechanisms that *usos y costumbres* institutions harness (Curtin et al., 2024). Future work should take a comparative psychological approach to investigate how the strength of internalized norms, ingroup prosociality, perceived interdependence, and other features of social psychology vary with *usos y costumbres* institutions.

Finally, future research should probe the source of the rich institutional variation in Oaxaca. That is, how can we explain the variation in the ability of *usos y costumbres* institutions to stabilize cooperation? Cultural evolutionary theory offers one hypothesis: cultural group selection. The cultural group selection hypothesis posits that intergroup competition facilitates the spread of cultural technologies that enhance cooperation, as more cooperative groups outcompete less-cooperative groups. Competition can take many forms, including selective copying (less successful groups copy the practices of more successful groups), violent conflict (war, raiding), and differential survival (cooperative groups are more likely to survive shocks such as natural disasters) (Richerson et al., 2016). Given the long history of inter-community agrarian conflict in Oaxaca (Dennis, 1987; López-Bárcenas, 2004; Yannakakis, 2008), a cultural group selection model predicts that communities which experienced more conflict in the past have more cooperative institutions today. Similarly, the great geographic and climatic variation within Oaxaca suggests that some areas may

be more prone to shocks such as landslides, flooding, and droughts than others. A cultural group selection model predicts that communities in more shock-prone areas culturally evolved more cooperative institutions. By testing these hypotheses, we may uncover the ultimate forces that shaped Oaxaca's rich institutional diversity.

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