EMERGENCE OF ENDOGENOUS LEGAL INSTITUTIONS: PROPERTY RIGHTS AND COMMUNITY GOVERNANCE IN THE ITALIAN ALPS*

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Abstract:

We study the community governance of common property resources with the goal of understanding why a legal institution is sometimes chosen over informal cooperation achieved through repeated interaction. After a game-theoretic and property rights analysis of the two regimes, we present empirical findings from pasture and forest management of 13th-19th century communities in the Italian Alps. The communities more likely to adopt a legal institution (a Charter) are generally less peripherical, have higher endowments of common property, and a larger population than the communities who don't have one. There is also support for a model of diffusion of this legal innovation from neighboring communities.

JEL: D23, Q2, K4
Keywords: Folk Theorem; Transaction costs; Sanctioning systems; Community enforcement; Common Property Resources

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I. INTRODUCTION

Different institutional arrangements that are equivalent in a frictionless world can have considerably different performances when enforcement of property rights and acquisition of information are costly. In such a context, why would anyone choose to build legal institutions when informal cooperation through repeated interaction is available? This study tackles the question by carrying out a game-theoretic and property rights analysis of management systems of common property resources in medieval and modern Italy. The answer focuses on the role of legal institutions in enhancing the performance of informal cooperation and in providing alternative punishment technologies.

We analyze data about the emergence of community Charters in about three hundred villages in the Trentino region of the Italian Alps. Forests and pastures were managed as common property for at least six centuries until Napoleon forcefully abolished this system in 1805. One might think that these rural communities offered the ideal situation for observing informal cooperation according to the Folk theorem: they were small and isolated in a mountain area; the villagers frequently interacted with one another; families' local roots extended back for several generations. Despite this seemingly ideal environment for voluntary, mutually beneficial cooperation, as early as the 13th century, villagers built specific legal institutions at the community level to establish property rights[1] and regulations (*Carte di Regola*).

[1] Allen (1998) defines property rights as "one's ability, without penalty, to exercise a choice over a good, a service, or person" and transaction costs as "the costs of establishing and maintaining property rights." See also Barzel (1997) and the classical article of Demsetz (1967).

We find that the communities more likely to adopt a Charter are those with more difficulty in monitoring the cooperation level of other resource users and where more problematic is the coordination on the punishment of free riders. Moreover, communities with a smaller endowment of common resources less frequently adopt a Charter to manage its commons because of the existence of a fixed cost in building the legal institution. The timing of adoption of the Charters seems to be strongly influenced by the presence of other community with a Charter, especially neighboring communities, as if this legal innovation was spreading by imitation.

The structure of the paper is the following. After a literature review (Section 2), the framework of analysis is described in Sections 3-7 and tested in Section 8 using an event history model. The conclusions are in section 9. A roadmap for the framework of Sections 3-7, which is constructed by steps, is now presented. First, the well-known inefficiency in the unregulated use of a common property resource is outlined and the possibility of raising efficiency in resource use through repeated interaction among users is introduced. In particular, there were ways for the villagers to lock themselves in a continuous relationship and to restrict immigration (Section 3). Second, the issue of costly enforcement of property rights toward outsiders is explicitly embedded in the model and anecdotal evidence from the Trentino communities is reported (Section 4). Third, the issue of imperfect monitoring of cooperation levels of other users is discussed theoretically and in the context of the field case. When monitoring of others is imperfect, the group surplus from a repeated game interaction is in general less than optimal (Section 5). Fourth, Section VI introduces the alternative arrangement of a legal institution and in particular compares legal and informal sanctioning. Finally, Section

7 includes comments on the modalities of transition from one management regime to another and discusses reasons for a diffusion model.

2. LITERATURE REVIEW

This paper builds on previous work done in the areas of economics of property rights, self-governing institutions, and the theory of repeated games. Following Greif (1998), we define institutions as "non-technologically determined constraints that influence social interaction and provide incentives to maintain regularities in behavior". As Knight (1992) points out, institutions can be both legal and informal. Then we distinguish between *legal institutions,* which are legal constraints that can be enforced in court and *informal institutions*, which are constraints that do not rely on a court of law neither for defining what constitutes improper behavior nor for administering punishment. Within the latter category, we single out *informal cooperation,* which is the coordination in a repeated game on a strategy that supports an equilibrium yielding a better group outcome than the inefficient equilibrium outcome of a one-time interaction. An agent is thus said to 'informally cooperate' when he reduces his use of the common resource to below his one-stage best response level and in this way his action increases the group surplus.

A central thesis of the paper is that legal institutions evolved because they complemented existing informal cooperation and increased efficiency. Demsetz (1967)'s classic paper on property rights explained the emergence of private property rights among the Montagne of Quebec as rising from an increase in the value from the land due to fur trapping. The data from the Italian communities provides a "natural experiment" to carry out a test to study the effect of the potential gains associated with ensuring greater exclusivity in determining the development of property rights regimes. Stevenson (1991) also studied common pastures in the Alps and

provided a very clear framework to study common property rights. While his focus was on productivity comparisons of private versus common property pastures, we explore alternative governance regimes on common property resources.

The class of legal institutions here considered is the one of self-governing institutions, where a group of agents establishes a set of legal rules for their members and an organization to implement those rules. The literature describes dozens of cases of self-governance of common property resources for coastal fisheries, forests, grazing land, and water resources (Bromley, 1992). In particular, Ostrom (1990) did a remarkable work in identifying the patterns that distinguish fragile legal institutions from long-enduring ones. The community Charters have all the features that Ostrom (1990) found to be shared by long-enduring institutions. The purpose of this study is to build upon these empirical regularities and to provide a theoretical interpretation for why self-governing institutions emerge. In other words, why sometimes people govern themselves largely by means of informal rules without the aid of a state, as Ellickson (1991) has nicely shown, while in other instance they build legal institutions.

Tools similar to the ones here employed were applied with success to decipher ancient trading institutions, among others, by Clay (1997), Greif (1993) and Milgrom, North and Weingast (1990). As these authors point out, the key to understand those pre-modern trading institutions is the theory of repeated games with imperfect monitoring (Green and Porter, 1984; Abreu, Pearce and Stacchetti, 1986, 1990; Fudenberg, Levin, and Maskin, 1994). This study differs in two important ways from the ones mentioned. While Greif (1993) and Milgrom, North and Weingast (1990) take a long-term interaction among the agents as granted, we inquire about what did promote stable intra-community ties when there was political freedom to migrate and where the common land could be traded. Moreover, the focus here is

not on long-distance trade but on land use, which exhibits different issues such as the possibility of trespassing.

3. COMMON PROPERTY RESOURCE USE

Left to unregulated short-term individual decision about exploitation, a common resource such as a pasture or a forest, would be overexploited, and its output would be far below its potential. The outcome though could be more efficient when resource users are in a long-term relationship.

Gordon (1954) has introduced a model for the use of an unregulated common fishery that has become standard for common property resources. When users independently choose appropriation efforts $q_i \geq 0$, say hours spent in the forest to cut timber, individual profits are $\pi_i = \frac{q_i}{Q} Y - cq_i$, where $Q=\Sigma_{i=1,..N}\ q_i$ is the total appropriation effort and $Y=p \cdot g(Q)$ is the value of the catch derived from the quantity captured, g(Q), times the unitary price, p. The group surplus (profit) is simply $\Pi(Q)= \Sigma\ \pi_i = Y-c \cdot Q$. This expression can be rewritten as a fraction of the optimal surplus, Π^* that is achieved at Q^*:

(1) $\Pi = E(Q) \cdot \Pi^*$, where $0 \leq E(Q) \leq 1$

The resource is overexploited at the symmetric Nash equilibrium (NE) compared to what is the optimal appropriation level, $Q^{NE}>Q^*$, and group surplus at Nash equilibrium, Π^{NE}, is below its potential, Π^*, $E(Q^{NE})=4N/(N+1)^2<1$.[2] An exhaustive treatment can be found in Clark (1990) and Baland and Platteau (1996).

[2] Notice that $E'(Q)<0$.To derive it compute $q''_i = \text{argmax}\{\pi_i\}$. Under the assumption of symmetry, $q''_i = q'' \ \forall i$, $Q^{NE}=N\ q''_i$. Define $E(Q^{NE}):=\Pi^{NE}/\Pi^*$. Moreover, it follows that $E(Q^{NE})<1$ for any $N>1$.

When the interaction among users is repeated over time and appropriation efforts are perfectly observed, cooperation levels higher than the Nash equilibrium can be supported and the group surplus, Π^R, can be above the one-shot case ($\Pi^R > \Pi^{NE}$) (Rubinstein, 1979). In general, the potential level of cooperation depends on the discount factor δ. One could decompose the discount factor into a time horizon λ and a patience τ components, where $\delta=\lambda\cdot\tau$ and $\lambda, \tau \in [0,1]$. Patience τ could depend on the interest rate, $\tau=1/(1+r)$, while the time horizon λ is related to the probability that the interaction with the group is going to take place in the following period. The full efficiency outcome can be supported in equilibrium when the agents are perfectly patient and there is complete confidence that the repetition is infinite ($\tau=\lambda=1$) but the group cannot improve upon the one stage solution when either the agents are not patient enough (for instance $\tau\rightarrow 0$) or the chances of indefinite future repetition are not high enough (for instance $\lambda=0$). The more the group of users is likely to remain together in future interactions the higher is λ. Hence, any technology that locks the agents into the group by increasing the value of λ improves the chances of high levels of cooperation. We are now going to consider how the community Charters dealt with the stability over time of the community of users.

In Trentino, the region under study, common property at the village level on pastures and forests was widespread. In order to better manage their common resources, the communities had mechanisms to ensure that the interaction was repeated and to govern the access to the commons by immigrants.

Villages were generally very small. In 1810 there were more than 300 villages in the Trentino region and 80% of them had less than 1000 inhabitants. The median size was 410 people, which corresponds on average to 80 families. A common property resource was shared among people

of the same community, which was mostly limited to one village. The region is a mountain area of about 2400 square miles situated Northwest of the Republic of Venice. Forests covered about half of the area while grazing land and meadows covered about one-third,[3] and an overwhelming portion of both was owned in common. Land register data from two villages show that in 1780 almost all forests were common ownership (100% and 95%) and so were about two-thirds of the meadows and pastures (60% and 66%).[4]

As the peasants were not forced to live in the village where they were born and as there were hundreds of separate communities, there is no obvious reason to assume a long-term interaction within the same community. Without a long-term relationship among the legitimate users - the insiders – no informal cooperation could be achieved. The long-run interaction among the insiders was achieved through specific property rights arrangements.

The villagers were locked into a long-term relationship with one another because the individual decision to leave the community in which a peasant was born involved losing the right to use the common land, at least while not presently living there, possibly for longer than that, and sometimes forever. Other features of the property right arrangement further support the view that it was an explicit intention of the community to set up a lock-in mechanism. These details were vital in ensuring a continuing interaction and, therefore, the applicability of Folk theorems to this situation.[5]

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[3] The exact data are 48% and 31%. Source: 1897 land register data reported in Consiglio Provinciale d'Agricoltura, 1903.

[4] The two villages are, respectively, Predazzo and Levico. The data are from the *Catasti Teresiani of 1780-90*, manuscripted books recording ownership rights (*Archivio di Stato di Trento*). Goio (1978) reports the summary statistics for the village of Levico and Varesco (1981) for Predazzo. A more systematic study of the extent of common property using 1780 data has not yet been carried on. A 1897 survey for the whole Trentino reveals that more than 76% of the forest in the region was municipal or State owned.

[5] Support for the statement that there was limited mobility of males across communities comes from the list of participants to the general community meetings. A comparison of last names at intervals of one or two centuries provides a proxy for mobility. The reason is that, first, most last names are village-specific; second, both membership rights and last names were transmitted through male lineage. Last name lists reveal little change within

In other words, there was an individual right to exit the community but exercising such right was costly. The crucial point is that anybody had the political freedom to leave the village, but no claim could be made of the community common resources. An insider could sell his individually owned house and fields but not his share in the community land. According to current property laws, if three persons own a piece of land in common and one of them wants to get out of the estate for no reason, he has the right either to sell his part to anybody or to be refunded by the other two. The arrangement in the north Italian villages was rather different. No Charter ever mentions the right of an insider to be refunded the value of his share of common land in the case he leaves the community, let alone the procedures to satisfy that right, but they prohibit the trading of rights to membership. Instead they state the suspension of benefits and other punishments for the person who leaves. To begin with, if a community member no longer lived in the village, he could no longer use the common resources. In addition, if he returned to the village, he had to perform his chores upon his return to the community, but sometimes could not use the common forest and pasture for one additional year.[6] Although in a long-term relationship within the community, villagers could and did travel outside the village. In fact, seasonal migration was a widespread phenomenon and is compatible with maintaining strong community ties.

The rights of alienation and division of the common properties were specifically designed in a way to safeguard the lock-in mechanism that we have just described. These aspects of the property rights arrangement further support the interpretation that they were aimed at

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each community. This proxy is not perfect because a family name can also disappear for natural death, especially in the long run, and new last names can come up as modifications of old last names.

[6] From Statuti et Ordini della Spet. Comunità di Nago e Torbole (1683): Nago and Torbole, 1647: "*Cittadini, che non habitaranno non possino goder beni communi*" (c.73: They cannot bring timber outside the village borders; they can use the common land only if they still have individually owned land in the village). "*Cittadini, che partono dal commune, et ritornano, che non possino goder beni communi, se non passato un anno*" (c.74).
See also Tres, 1551 (the 1599 modifications regulates the insider status) and Casez, 1632, c.45

promoting a long-term relationship. For instance, Parcels of the common forest and pasture were sometimes assigned to the members of the community in exclusive individual use. Such assignments were internal arrangements and the external legal property rights on the land always belonged to the community. In fact, when a member left the village, he had to also return his individual assignment to the community because it constituted a proper portion of the common resource.[7] What could have been a threat to informal cooperation was an individual right to sell a share of common land to others. An insider did not have this right. Otherwise, he could have taken advantage of the common resource by generously appropriating timber and overgraze the common pastures and then alienate his property right before the others would punish him using a Tit-for-tat strategy. That is why the right to sell the common land was always a collective right that belonged to the community as a whole. The community Charters required the consent of a wide majority of the insiders for the alienation decision.[8]

To summarize this point, the property rights arrangement on the common land promoted a long-term interaction among the insiders, because the option to exit the community was costly. The individual insider had the right to use the common resources according to the community rules and the right to participate in shaping those rules but no right to secession with compensation. Under these conditions, free riding was not profitable because avoiding the cost of the punishment involved facing the greater cost of leaving the community.

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[7] Meadow assignments can be found in Pradibondo 1221, Condino 1340-3, Storo 1347, Nago-Torbole 1533, Caderzone 1591 (Papaleoni, 1891, Papaleoni, 1892, Valenti, 1911, Dossi, 1913, 1927).

[8] A qualified majority of at least 2/3 was required to sell the common land in Cles 1641, c.5 and in Cis 1587, c.80. Some authors interpret the absolute prohibition to sell the common land as a pivotal aspect of the traditional land management of the Trentino communities (Andreatta and Pace, 1981). In this paper I argue that this statement is not empirically correct and that it is not a requirement from a theoretical point of view to ensure a long-term relationship among users. Absolute inalienability and indivisibility of the commons were not cornerstones of the historical form of common ownership in Trentino, although selling the commons was sometimes subjected to the authorization of the feudal authorities (Cagnò 1587, c. 3, modification of 1693). An interesting discussion about the role of tradability of property rights in the commons can be found in Seabright (1993).

Another issue was the admission of immigrants as users of the commons, which was regulated by a system of village citizenship. The pillar of such a system was the distinction between the group of legitimate users and regulators of the commons, called the *vicini* (insiders) and all the others, called the *forestieri* (outsiders).[9] The most rewarding free-riding action was probably to settle down in a village with a high per capita endowment of common resources and acquire full rights to use the commons (increase in N). Formally, when all users appropriate the resource at the same rate, the addition of a new user to a group is equivalent – for the original N agents – to alienate at least 1/N of the value of the resource.[10] Two safeguards were in place to filter people that wanted to settle in a community and use its common resources. First, the community needed to give explicit approval before an outsider could use the commons, or even before settling down in the village. The insiders wanted to screen out candidates not trustworthy and would sometimes ask prospective residents for convincing proof of an honest life and of decency.[11] To admit a new user, a nearly unanimous consensus was required.[12]

Secondly, the newcomer had to pay an annual fee. Admitting additional users on the common resource meant giving away a share of the claims on the resource profits, which is equivalent to alienating a portion of the property rights. The existing users wanted not only to have a say about the admission decision but also to be compensated for the reduction in their share of resources. In corporate law, this right is analogous to the right of shareholders to deliberate about

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[9] Examples of *forestieri* were the residents of neighboring villages, seasonal workers living in the village, occasional travelers. Similar systems were adopted in other regions of Europe (Popkin, 1979).

[10] When the group is informally cooperating the *same* group surplus are divided into N+1 parts instead of N. When the outcome is the Nash equilibrium solution, a *lower* group surplus is divided in N+1 parts.

[11] Cles 1641 (modification 1719, c.2, "*attestati autentici della sua buona vita et costumi*"). In addition to requiring the prospective member to give good references about his reputation, Nago and Torbole required some form of real warranty in case of mis-behavior. For instance, see Nago and Torbole 1647, modified in 1670, c. 72: outsiders cannot stay in the village for more than 3 days unless they own a piece of land or a house (*stabili*) worth at least 200 fiorini . No outlaw could be accepted (*banditi* or *ricercati*).

[12] Not all Charters described the admission procedure. Three examples areCis, 1587 (all but 3 dissenters), Cles,1641, Tres, 1551 (unanimity required in 1599)

the issuance of new preferred shares and decide about their price. Interestingly enough, in 1671 the peasant assembly of the village of Cis stated - in the very same article of their Charter - that admitting a new member had to be deliberated with the same majority as the one adopted for selling the common land (any group of three or more insiders could veto the decision).[13] The annual fee was usually assessed on a case-by-case basis and in proportion to the expected use of the forest and pasture, looking at the size of the family or the number of animals owned.[14]

4. EXTERNAL ENFORCEMENT OF PROPERTY RIGHTS

Legal property rights that protect the group of users from outsider intrusions, such as trespassing, need to be enforced in order to be economically meaningful. The simple model presented in the previous section implicitly assumes perfect enforcement. When the decision about the level of enforcement is considered, different conclusions might follow. A lack of external enforcement can make the use of a common resource even more inefficient than the Nash equilibrium level and might reduce group surplus to zero. When enforcement is considered, group surplus for the N insiders in the one-stage interaction can be written as[15]

(2) $\Pi = e \cdot E(Q(e)) \cdot \Pi^* - c(e)$

With perfect enforcement (e=1) the actual users (M) are just the legitimate ones (M-N) while, with zero enforcement ($e \to 0$) the resource is open access and the number of actual users

[13] See the modification to Cis, 1587, chaper 80: "*... alienare beni comunali o ricevere alcuno forestiero per vicino se meno di 3 vicini son contrari*" .

[14] For example Cles, 1641,c.57: "*Che li forestieri habitanti nella communità di Cles siino colettati dalla regola per l'honesto in loro arbitrio, considerando la loro qualità et animali che tengono sopra li comuni, et in più concorrino ad ogni cosa ordinaria et straordinaria come li vicini,...*". See also Tres, 1551 and following modifications.

[15] Trespassing lowers the one stage Nash equilibrium surplus for insiders in two ways. First, the overall outcome for the M users worsens as a result of the increment in effort Q. This phenomenon is very similar to the effect of increased group size on efficiency (principle underlying Proposition 2). To be more precise, as enforcement becomes negligible the efficiency level of the resource use goes to zero, $\lim_{e \to 0} E\left(Q^{NE}(e)\right) = \lim_{N \to +\infty} E\left(Q^{NE}(N)\right) = 0$. Zero efficiency means that the revenues collected from the resource are just enough to cover the harvesting costs.

Second, a lower fraction, e, of that outcome goes to the insiders because the rest is stolen (notice that e=N/M).

is theoretically infinite, M:=N/e, where e∈[0,1]. The value (M-N) accounts for the appropriation by outsiders of the group.[16] Avoiding the damages from trespassing comes to a cost. The legitimate users can choose an enforcement level e by paying a cost c(e), which is assumed to be weakly increasing in enforcement effort but infinitely high when pursuing perfect enforcement.[17] Formally, $c \in C^1[0,1)$, c(0)=0, c'≥0, and $\lim_{e \to 1} c(e) = +\infty$. A necessary condition for the insiders to maximize the group surplus is to choose an enforcement level e=e* where the marginal benefits of preventing trespassing b'(e) equals its marginal costs c'(e),

$$(3)\ 8\Pi^* \left(\frac{N}{e}\right)^2 \Big/ \left(\frac{N}{e}+1\right)^3 = c'(e)$$

From (3) follows the standard results of property rights literature. In equilibrium, an increase in the value of the resource Π* leads to a higher level of external enforcement e*. Symmetrically, a decrement in the marginal cost of enforcement c'(e), such as when adopting a Charter, leads to a higher level of external enforcement e* and to higher group surplus. Notice that given the assumption of infinite costs for perfect enforcement, in equilibrium enforcement is never complete, e*<1, because marginal benefits are always finite.[18]

These main conclusions do not change when considering a repeated interaction scenario. Instead, when appropriation actions cannot be perfectly observed, there are additional

[16] In practice there might be more than M-N individuals trespassing but their use of the resource has a similar effect of additional M-N insiders.
[17] For simplicity we consider an enforcement cost function c(e) that depends only on enforcement effort. In practice, c(·) is likely to depend on other factors such as the location of the resource.
[18] With infinitely repeated games there are multiple equilibria. The comparative static statements in the text are made in reference to the best equilibrium, i.e. the one that leads to the highest group surplus for the insiders.

feedbacks between supporting cooperation within the group of insiders and trespassing activity that will be discussed in the next Section.[19]

Without restrictions to immigration and trespassing, the community land would be in practice available to everyone. As it will be shown, the commons in northern Italy were common property and not open access resources. First, as already described, there was a form of village membership to govern the access by immigrants. Second, there was a system of decentralized enforcement of property rights toward illegal trespassing. The community Charters provided the legal tool for the delegation of jurisdictional powers from the Prince courts to village officers to facilitate this second task. Although it did not result in perfect enforcement of property rights, this institutional innovation decreased transaction costs of common ownership.

Since sneaking into the community as a would-be new member went hardly unnoticed (increase in N), outside free riders could devote their attention to a more classical activity, trespassing (increase in M given the same N). Such action was unanimously prohibited in the community Charters. Outlawing trespassing though was not enough to eliminate it.

Enforcing the legal property rights on the common forests and pastures was beneficial for the community, but using the state court system to protect the property rights was often impractical because of the high costs relative to such small matters as a stolen tree. The community Charters emerged in the 13th century as a legal innovation to reduce the transaction costs involved in enforcing property rights on the land.[20] Villagers negotiated a set of rules among themselves in a general meeting, would call a notary to write them in a contract, and petition the Prince of Trento

[19] Two notes on the informal cooperation case. With the exception of the extreme case of no external enforcement (e=0), cooperation through repeated interaction always generates gains. When there is full cooperation, the optimal enforcement effort is lower than with no cooperation, because the marginal benefit of enforcement b'(e)= Π^* is always lower than in the one stage case (for N>1).

[20] The oldest known of such Charters dates back to 1202 and was drawn by the small village of Civezzano, near the administrative center of Trento.

for approval. This process was always initiated by the communities. The approval of a Charter operated a partial delegation of judicial powers in economic affairs from the Prince courts to a local community, which generally included the powers to appoint guards and inflict monetary sanctions on trespassers.

From the community standpoint, this decentralization lowered enforcement costs and can be modeled as a downward shift of marginal enforcement costs. In exchange for this more effective enforcement technology the government asked for a payment.[21] This transfer generally took the form of a share of the collected fines, either one-third or half. As the actual size of the surplus gain was largely unknown to the government, a lump sum payment would have been hard to determine. This payment cannot be considered a cost of this legal arrangement but rather the result of rent extraction.

Even with a more efficient, decentralized enforcement of the property rights, not all trespassing was discouraged. The enforcement of property rights was in fact likely to be incomplete because of the monitoring costs and the costs of collecting the fine. In support this statement one can find record of fines. For example, the 1677-78 administration booklet of the community of Coredo lists at least ten fines extolled from outsiders, oftentimes for cutting trees in the village forest.[22] If a trespasser was caught he had to refund the market value of whatever he harvested and in addition pay a penalty. The activities of detecting a trespasser, bringing him to court, and collecting the fine were all time-consuming activities. If either the potential damage was small or the action was too difficult to detect then the community would not profit by engaging in a

[21] In a sample of 23 Charters in the years 1580-1650, such payment was required from 35% of the communities.
[22] From the *Libri de Conti della Honoranda Comunità di Coredo:* "*ricevuto per condane fatte alli sottoscritti come forestieri*" (1677-78). There are other reports of fines where it is not specified if the payment came from insiders or outsiders: "*per due larici taliati nel ingazato, e venduti a Sfruz*" (1672-73), "*per haver tagliato un pez dent in sas nella sorte*" (1673-74), "*per il valor di legni menati dal monte con buoi forestieri senza licenza*" (1677-78).

stricter enforcement of property rights. For instance, detecting trespassing during the night requires a higher effort. In order to discourage it, the community usually doubled the penalty.

Moreover, the effort and outcome of external enforcement were greatly influence by topography. In fact, natural barriers such as mountain ranges or rugged creeks could sometimes stop trespassers with no effort on the side of the community. The villages of Romeno, Don, and Amblar provide a colorful instance of the role of topography. The peasants of the three villages owned in common a side valley mainly covered by forest. The valley was delimited on three sides by steep mountains and in the only side where access was feasible, the entrance was so narrow that villagers built a gate on it and provided the gate with a lock. As the 1459 Charter states, the only key was kept in the church of the village of Romeno. In this way the community governor could have easily controlled everybody who went into the valley to log trees.[23] Because of a different topography, other communities faced widely different constraints and levels of potential trespassing.

In conclusion, a Charter provided a more efficient deterrence mechanism against trespassing. Even so the restriction of the access to the community land to the legitimate users was never perfect and likely to vary in degree across communities because of topographical specificities.

5. EXTERNAL ENFORCEMENT AND IMPERFECT MONITORING

Informal cooperation can be less than optimal when agents cannot perfectly observe each other's actions. This section discusses the effects of imperfect monitoring on efficiency with the additional complication that external enforcement levels affect the quality of monitoring. Moreover, the information on cooperation levels could be either public or private.

[23] The reference is to the villages of Romeno, Don, and Amblar. Regulation of the gate is mentioned in the 1459 community Charter (chapter 24: *Item che la chiave della porta di Vallavena sia tenutta et conservatta nella sacrestia della chiesa di santa Maria di Romeno*).

Consider a situation where agents have only an imperfect measure of the cooperation level of insiders, in particular a noisy signal of aggregate cooperation, such as some information about the current physical stock of the resource, which is gathered during the harvesting activity. We assume that individual actions are not observed. The signal is correlated with the true level of group cooperation, given by the overall appropriation efforts Q, but contains a noise term ε reflecting observational imperfections. In particular, it could be written as $s = g(Q) + \varepsilon$, where s is the signal about the physical stock of the resource (status), g is the biological production function, Q is group appropriation effort, and $\varepsilon \sim (0,\eta^2)$ is a random element. When dealing with a common pasture, s could be the outcome of a day of grazing in terms of milk production, while Q is the overall number of animals on the common pasture, and g represents the biological production function for grass, given the harvesting effort Q.

When s is a public signal, all users infer the same level of cooperation $\hat{Q}$. The optimal strategy in equilibrium is then to revert to a punishment mode when $\hat{Q} > \overline{Q}$ (Abreau, Pearce, and Stacchetti, 1986, Green and Porter, 1984) but such strategy cannot in general support full cooperation, i.e. $\overline{Q} > Q^*$:

$$(4)\quad \Pi^{GP}(\delta) = (1-\alpha)\frac{\beta\Pi^*}{1-\delta} + \alpha\frac{\underline{\Pi}}{1-\delta}, \quad \text{with } \underline{\Pi} < \beta\Pi^*$$

In this expression, adapted from Green and Porter (1984), the parameter $\alpha \in [0,1]$ indicates the fraction of periods of in which the agents are in punishment mode and $\beta \in [0,1]$ the level of surplus that is achieved in the cooperative periods in comparison with the maximum potential, Π^*.

For any given discount rate δ, the less informative is the signal σ(s), in the sense defined below, the lower the maximum level of cooperation that can be supported in equilibrium

through repeated interaction. This result follows from $\partial\alpha/\partial\sigma(s)>0$ and $\partial\beta/\partial\sigma(s)<0$ in (4). With some qualification the same result holds more generally for any symmetric repeated games where there is imperfect public monitoring (Abreau, Pearce, and Stacchetti, 1986, 1990; Fundenberg and Maskin, 1986, Kandori, 1992a, Fundenberg, Levin, and Maskin, 1994).[24] In particular, Kandori (1992b) has proved that in an Abreau, Pearce, and Stacchetti (1986) environment, a more informative signal about cooperation levels in Blackwell's sense, weakly improves the maximum level of group surplus Π^{GP} that can be supported in equilibrium[25]

There are two issues related to the basic results just stated, one regards the impact of external enforcement on the highest level of surplus that can be supported in equilibrium and the other whether the signal is private or public.

Besides observational imperfections of the physical stock of the resource, there is a second source of noise in the signal when the level of external enforcement is a random variable. Consider a situation where paying an enforcement cost c(e) allows a draw from a random distribution of enforcement levels with mean e.

$$(5)\quad s = g(Q(M)) + \varepsilon \qquad \text{where } M \sim (N/e, \xi^2) \text{ and } M \perp \varepsilon$$

Overall, the informativeness of the signal $\sigma(s)$ is influenced by the level of external enforcement of property rights as the value of s depends on the actual realization of the random

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[24] Abreau, Pearce, and Stacchetti, 1986 formalize the problem using a different and more general metric than Green and Porter, 1984. Moreover, when the signal is public and it satisfies an identifiability condition, if the discount rate is sufficiently close to one, any individually rational payoff can be supported as the average payoff of an equilibrium of the repeated game, including the optimum outcome (Fundenberg, Levin, and Maskin, 1994).

[25] This point was proven by Kandori (1992b). In particular, under the conditions that the signal space is continuous while the action space is finite. The accuracy of a signal refers to Blackwell's definition of informativeness. Suppose there are two potential signals s^0 and s^1 for action profile q. The signal s^1 is worse than s^0 in the sense of quasi-garbling. That is, if $g^1(s^1|q)$ and $g^0(s^0|q)$ are conditional probability densities, then there exists a function $\phi(s^1|s^0)$ such that $\phi(s^1|s^0)>=0$ a.e. s^0 and s^1; $\int \phi(s^1|s^0)ds^1=1$ a.e. s^0 ; $g(s^1|q)= \int \phi(s^1|s^0)g^0(s^0|q)ds^0$ (Blackwell and Girshick, 1954, chapter 12). For example, consider $s^0 = h(s) + \varepsilon$ and $s^1 = s^0 + \varepsilon'$, where q, ε, ε' are independent, then s^1 is a quasi-garbling of s^0. A garbling is a random variable whose distribution depends on the underlying state of the world only through its effect on the intermediate signal.

variable e. A more intense external enforcement of property rights e can generate two beneficial effects. First, it reduces the level of thefts on $\prod^{GP}$. This effect has already been considered in the previous Section. Second, it can induce a more informative signal σ of the level of resource use by the insiders, and hence possibly to higher surplus levels, $\prod^{GP}$. When both enforcement costs and imperfect monitoring are considered, group surplus is

$$(6)\ \prod^{R} = e\prod^{GP}(e) - c(e)$$

The second issue is about the nature of the signal. A public signal s is an important device in helping to coordinate the group in cooperating and punishing. If there are just private signals s_i with i=1,…,N, the relevant histories of play are not public, which makes the analysis less tractable because there is a lack of common knowledge of the histories that triggered punishment (Kandori and Matsushima, 1998; Compte, 1998; Mailath and Morris, 2001). When signals are private, however, an institution might be built to aggregate them and generate a public signal, $s=s(s_1, s_2,\ldots, s_N)$. For example, in Abreau, Pearce, and Stacchetti (1986) the task of generating a common price signal for all the oligopolists is accomplished by the product market.

To sum up, in the context of a common-property resource use with imperfect monitoring, information-gathering institutions could be useful in two ways. First, to improve the accuracy of the signal s in Blackwell's sense. Such institutions could raise the cooperation level that can be supported through repeated interaction, and might more than compensate for their cost. Second, to generate a public signal out of private signals, which improves coordination in punishment. We now apply these concepts to the Trentino case study.

Once property rights on the common resources are legally well defined and enforced and once insiders face a continuing relationship, informal cooperation can be sustained provided

that each insider can assess the cooperation level of the others, so that he could decide whether to keep cooperating or to switch to punishing. An insider had two ways to assess the cooperation level of the others. One way to detect cooperation levels was to monitor the individual actions $q_1,\ldots,q_N$ directed at resource use of all the other insiders. A second option was to look at the physical stock of the resource g(Q) and from it to infer the aggregate cooperation level of all the other insiders Q, for the given level of external enforcement. In the northern Italian communities both ways of assessing cooperation were imperfect and specific institutions were set up to improve observability.

Several facts suggest that full monitoring of individual actions of insiders was problematic. Consider, for instance, the common prohibition of harvesting grapes in individually owned vineyards before a date designated by the village assembly. This apparently odd rule is quite sensible when monitoring is imperfect or costly. If all peasants were in the vineyards to harvest the same day, they could have checked one another's behavior at no additional cost. Without this regulation, instead, it would have been easy for a peasant to pick the grapes of his neighbors without being noticed.[26] In addition, during the weeks before harvesting day, the community paid a guard to police the vineyards all day long - and sometimes all night, too. The existence of guards indicates that monitoring was costly but necessary. [27]

More generally, there was widespread fear of thefts from the fields. There were frequent complaints of robberies of fruits and vegetable. In order to reduce this risk, the peasants adopted inefficient agricultural practices, such as tiny vegetable gardens located near houses

[26] This rule was almost always there if there were vineyards in the village (see table 1). For an example see Tassullo, Rallo, Pavillo and Sanzenone, 1586, c.30, 52, 60. One reason was to collect the *decima* (tax on the harvest) but fear of thefts were relevant as Sanzeno (villa), 1586, c.27 makes clear: in case somebody needs to harvest a day before "*che ogn'uno sia obligato lasciar da vendemar appresso li suoi confinanti: che non debba integralmente vendemare in un luogo, havendo confinanti, et questo si apparerà alli regolani; et che quello il quale vendemerà sia obligato avisar li decimani che vengino pigliar la sua decima*".

[27] For an example Vigolo Vattaro, 1496, c.22

and small areas devoted to orchards.[28] Sanctions for thieves were doubled when monitoring was particularly difficult such as at night or if the thief was an outsider.[29] A further example of imperfect monitoring was the prohibition to stay overnight or during religious holidays in the high mountain meadows and forests. The 1586 Charter of Sanzeno explains that the aim of the rule was to avoid free riding on the common resource or thefts in individual plots. Given that everybody else was in the village or observing the no-work custom, the free rider would have been difficult to catch.[30]

In conclusion, individual appropriation actions of insiders were not public information. On the contrary their knowledge required in general costly monitoring activities. The examples given above show however how appropriate information-gathering institutions could bring a community closer to an ideal situation of perfect monitoring.

In alternative to monitoring individual actions, a villager could have inferred what others had harvested, and thus whether they were cooperating, by simply observing the physical stock of the common forest or pasture. In other words, instead of observing the people the villagers could have observed the land. The signal collected in this way, however, was not necessarily precise. The villagers had a good idea of the physical stock of the resource, but did not know exactly how many trees were in the forest or the exact quantity of grass that was on the ground in comparison with the level to be found if the harvesting was optimal. Moreover, the

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[28] For references from community Charters, see for instance Malosco 1593, c.25, 26 and Tres 1551, c.53, 54, and 55. Monteleone (1964), pages 34-37, provides clear evidence for the years 1810s when the community Charters were abolished. Not only were grapes stolen, but the wooden supports from the vineyards as well.

[29] For two among many: Salter and Malgolo, 1586, c.26 (fines doubled at night); Sanzeno (villa), 1586, c.13 (fines doubled for outsiders), c.6 (differential treatment of outsiders from insiders: need to leave timber in the village for three days).

[30] Pieve di Sanzeno, 1586, ch.23: "*Item per tor via molti abusi et cative usanze et cativi costumi che per alcuni che per il passato si ha fatto, si statuisce che niuno della pieve non debba, né anco forestiero ardisca, di stare di notte, né dì di festa, eccetto che il gazaro, uno over più, in la montagna predetta ed massime nel tempo della segagion ed mentre è ancor il fieno nelli pradi: sotto penna de lire cinque per cadauna persona; ed se fosse rubato fieno ad alcuno over legnami over anco taiato legnami (…) che si imputi tal furto ed contrafacion a quello over quelli che si trovarono esser stati la note over il giorno di festa sul monte*", see Cagnò, 1587, c.43 for a more generic rule against working during holidays.

undetected appropriation by outsiders was an additional and independent source of bias because the same stock of resource could have been the results of various combinations of insider and outsider appropriation levels. Since the enforcement of property rights toward outsiders was not absolute, the theft of an outsider could have been mistakenly interpreted as free riding behavior of an insider and triggered a punishment. The extent of this ambiguity was not the same for all communities. Given two communities A and B that derive the same benefits from external enforcement $b_A(e)=b_B(e) \ \forall e$, we say that community A is more protected from trespassing than community B if in an equilibrium without a Charter, $e^*_A>e^*_B$. Hence, Implication 1 follows:

Implication 1 (Remoteness)

The more remote the community, in the sense of being far away from towns and communication routes, the more likely it is of being more protected from trespassing. Hence, the remoteness of a community increases the relative efficiency of a repeated game solution.

On a different note, if users receive private signals instead of a public signal, cooperation is also more problematic. Suppose villagers sampled the status of the common land in different locations while doing their daily activities and did not usually cover the whole land. This individual heterogeneity in signals could easily make cooperation unravel in the absence of communication. Suppose that just one user believes that a violation occurred and switches to a punishing mode. The following period the increase in use could trigger everybody else's to punishing. A perturbation of any one of the private signals could provoke a cascade that drags the whole group to the punishment mode. Community meetings generated a public signal out of the private signals and hence promote coordination among agents in the choice between cooperation and punishment. In Trentino the Sunday mass or the general assemblies that were

events attended by virtually everybody. Several Charters even sanctioned with a fine the absence from assemblies where the commons' business was discussed.

Besides disseminating a public signal among all insiders, some institutions could actively gather information about how much the common resource was used and increase the informativeness of the signal. Generally, information-gathering and fact-checking institutions that come up with an 'official truth' are associated with formal punishment institution but in principle the two functions are distinct.[31] Establishing hard-wired procedures to decide when, whom, and how much to punish could avoid mis-coordination deriving from private information or heterogeneous subjective beliefs. These coordination failures are expected to increase with the numerosity of the community.

Implication 2 (Population)

The larger the group the higher the cost of coordination on informal punishment. Hence, communities with a large population are more likely to increase their efficiency by adopting a Charter than small communities.

To sum up, monitoring of insiders' cooperation level was imperfect but proper institutions could improve the efficiency of informal cooperation through the gathering, validation, and sharing of information.

6. LEGAL SANCTIONING: KEEPING AN EYE ON YOUR NEIGHBORS

Common property users can adopt the threat of a temporary overexploitation of the resource in order to foster cooperative behavior in similar manner that price wars are forms of

[31] For instance, in some Bolivian communities that rely on informal sanctioning institutions, the leader of the village publicly announces when somebody has violated a norm about the use of the common resource. The announcement works as a coordination device to trigger the informal punishment by all the villagers. Oral communication by Marco Boscolo, June 2000.

punishment used to sustain collusion in an oligopolistic market. All the insiders are involved in the punishment and this behavior is self-enforcing in the sense that no external authority is needed to administer it.

When monitoring is perfect the specific form of punishment threat chosen - as long as its level is high enough - is irrelevant for group efficiency as in equilibrium the threat is never put into practice. In the imperfect monitoring case here analyzed, instead, the group does sometimes switch to a punishment mode and the type of sanction technology adopted affects efficiency. In particular, price wars are costly because of the forsaken profits that can never be recouped. As price wars result in collective punishment and generate a deadweight loss, legal sanctioning can be a more efficient sanctioning technology. [32]

An alternative mode of punishment through a system of legal sanctions typically involves rules that restrict resource appropriation - for instance in the form of quotas - and individual fines for violators. A legal sanctioning system presents two advantages over a price war form of punishment. First, the punishment takes the form of a fine F, which is a transfer of resources within the group and not a destruction of resources. A fine involves a simple redistribution of resources within the group. By contrast, in the repeated game surplus described in (4), a period of punishment generates a deadweight loss of $(\Pi^* - \underline{\Pi})$. Second, the punishment targets the individual free rider and does not harm the cooperators. The free rider earns $(\pi_j\text{-}F)$ while the others still earn π_i. By contrast, in a price war each agent loses $(\Pi^* - \underline{\Pi})/N$.[33]

[32] The fact that we do not often observe formal regulations in oligopolistic markets is because cartels are illegal contracts. In order to overcome the unavailability of the otherwise convenient way of enforcing the agreement through courts, the oligopolistic firms use Folk-theorem type strategies.

[33] Another type of informal sanctioning is social ostracism that could take the form of refusal of a loan or of a marriage proposal, or simply of a greeting. Although individually targeted, this form of punishment is a deadweight loss for the community.

Legal sanctioning has two drawbacks. First, it relies crucially on the monitoring of individual resource appropriation actions, which is a costly activity. Second, it requires a court system to settle disputes about violation, which is also costly.

While collective punishment such as price wars can work with an aggregate signal of cooperation, legal sanctioning is based on the knowledge of individual violators. If the provision of information is left to voluntary actions, there is a problem of under-provision. Appropriate institutions needs to be set up to provide this public good.[34] Other legal institutions need to be created and maintained over time to settle disputes.

The community Charters established a legal sanctioning system to manage the common resources, which can be characterized by the following three elements. First, limitations to individual use, in the form of individual quotas, time, and place restrictions; second, monetary fines graduated with the severity of the violation in addition to the payment of the market value of the goods illegally acquired; and third sharing of the fines between the persons who brought the violators to justice, the community treasure, and the state government elites. An example is reported from the community of Mezzolombardo. On July 18, 1589, the governor of the village recorded that a gentleman named Michel had been caught while illegally collecting firewood on common land. As a result he had to pay a fine for an amount of *troni* 4 and *carantani* 10 in accordance with the community Charter.[35]

In order to inflict legal sanctions, community officers needed to know the identity of violators. Some information about insiders' actions was freely acquired as a byproduct of daily activities of the peasants, especially because of the small size of villages. As already

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[34] The external enforcement mentioned earlier presents a similar weakness.

[35] Libretto di Amministrazione (1589): "*per una codanaza fatta per aver menado entro legna da le giare del nos,*" which literally means "for a penalty inflicted for having removed firewood from the bank of the river *Nos*."
For the community Charters of Mezzolombardo see Devigili (1979).

mentioned, 80% of the villages had less than 1000 inhabitants. Still, there was under-provision of information in relation to the socially optimal level. In fact, providing information on the violations was a pre-requisite for rule enforcement, whose benefits were a public good.

In order to gather additional information about insiders' behavior, the Charters adopted three kinds of methods: a direct one - through guards hired to patrol the land - and two indirect ones – through an imposed re-organization of production to make actions more readily observable[36] and through a monetary incentive for whoever would discover the violation of a rule. All three ways involved costs to the community, which is evidence that a positive benefit was expected from it.[37] Some guards were hired to patrol the high mountain pastures and forests while others were in charge of patrolling the meadows nearby the village.[38] The guard received a share θ, usually one third, of a fine F collected from anybody caught breaking one of the Charter's regulations. This sharing rule provided an important incentive to engage in costly monitoring activities. In the Charter system, any insider could report a violation to the village governor and earn the reward instead of the guard if the report turned out to be grounded.

An optimal level of monitoring could be achieved by choosing appropriate levels for the fine, F, and the fraction for the reward, θ. As explained in (3), the optimal level of enforcement e^* is defined by the first order condition $b'(e^*)=c'(e^*)$. By rewarding inspectors, the Charter system can raise the agents individual incentive to monitor to a level that matches the social benefits of rule enforcement, $\theta F\ pr(e^*) = b'(e^*)$, where $pr(e^*)$ is the probability of discovering a

[36] For instance imposed harvesting timetables as mentioned in section V.B.

[37] Gathering information about insiders was costly but the same guards could be employed to report both trespassing by outsiders and insiders' behavior. The economies of scope of the two activities were likely to be very high.

[38] There were also guards for the vineyards (*saltari delle vigne*). Vineyards were nearly all in individual hands but there still was a need to enforce the property rights toward trespassers. This activity was organized collectively and regulated in the community Charters. Switching from village to individual ownership does not exempt from the need for external enforcement of property rights.

violation at the optimal level of enforcement e* and where $\partial pr/\partial e<0$. This mechanism ensured the optimal provision of information about insiders' behavior.[39]

One last disadvantage of legal sanctions was the sunk cost of creating and maintaining the legal institutions that administered justice. The insiders had to agree upon a set of regulations and to have constantly in place a court system. Writing an official document such as a community Charter involved non-recoverable costs, as did spending time in the community meetings or serving as a community officer.[40] That offers an opportunity for an empirical test:

Implication 3 (Minimum size of the commons)

Under the assumption of a fixed cost to set up and run a community Charter, all other things being equal, the higher the value of the common resources the higher is the potential gain of adopting a Charter. In particular, with an endowment of common property below a given threshold, it would be more efficient to rely on a repeated game solution than on a Charter.[41]

7. MANAGEMENT REGIME TRANSITIONS AND CONTAGION

So far we relied on the premise that describing what an institution does suggests why it exists and how it emerged (Knight and Sened, 1995). This section presents arguments in support of this assumption and discusses some consequences of the assumption not holding. Moreover, it puts forward a conjecture about a new factor influencing the adoption of a Charter, contagion.

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[39] For an experimental study of the Carte di Regola monitoring and sanctioning system see Casari and Plott (2001)

[40] There were however strong complementarities between building institutions to legally punish insiders and institutions for the enforcement of property rights toward outsiders. Both required appointing guards to monitor individual actions and once a guard was patrolling the forest looking for outsiders, it took little extra effort to report the actions of insiders as well. Prosecuting outsiders required courts and officials in charge of collecting the fine. The same machinery could be used for insiders. Notwithstanding these considerations, the extra monitoring efforts and the creation of legal regulations for insiders were costly to the community.

[41] As long as Charter creation and administration costs are less than proportional then the value of the common property, implication 3 would still hold.

The assumption that when a property right arrangement is more efficient it is going to be chosen by the agents is called by Eggertsson (1990) the naïve theory of property rights. In the context of a Charter adoption, it can be formulated in the following way. The group surplus with informal cooperation can be expressed as $\prod_1 = e \cdot \prod^{GP} - c(e)$, where e represents the level of external enforcement and c(e) represents its cost. On the other hand, the group surplus when a Charter is in place can be written as $\prod_2 = e \cdot \prod^{*} - c(e) - c(m) - C$, where $\prod^{*}$ is the optimal group surplus, c(m) is the cost to enforce the legal rules toward insiders and C represent the fixed cost to build and run a Charter. The assumption is that when for a community $\prod_1 < \prod_2$, a Charter is adopted. Two ways, in which this assumption can possibly be satisfied, through voting or competition, are now presented without pretense of an exhaustive discussion. A community Charter had to pass two tests of consensus. First, the village assembly needed to agree on a set of rules through a supra-majority voting procedure. Second, the local political authority, which in this case was the Prince of Trento, had the right to accept or reject the Charter.[42] It is well know from social choice theory that voting procedures often generate cycles and instability in the outcome or could have no core. How was this problem overcome in the case of the northern Italian communities? If we assume that there was homogeneity of interest among the villagers of a community, in the sense that either preferences were identical or highly correlated, then efficiency enhancing policies should have majority or supra-majority support.

The second incentive for efficient arrangements to emerge is due to competition among the communities. A better organization in exploiting a natural resource gives a community a higher income. Given that there were hundreds of communities in this region, an evolutionary-type of argument would suggest that the more efficient groups would take over the less efficient ones.

[42] There are instances where a Charter was approved under the condition that some specific provisions had to be changed. As it is for private contracts today, there was also a general framework of rules that no Charter could contradict.

According to this position a competitive market selects those contracts that generate the highest profits because the agents that take the most successful actions are going to thrive while the others disappear, especially in the six-century time perspective of our case study. The first to suggest this line of reasoning in Economics was Alchian (1950). A more formal argument is given in the fundamental theorem of natural selection, which states that evolutionary selection induces a monotonic increase over time in the average population fitness. This result is well known in biology but it does not apply to any game and for instance not to the Prisoner's dilemma (Weibull, 1995). When it does apply, there might be a short-term period of adjustment in the form of imitation of successful contracts or replacement of low-efficiency communities by high-efficiency communities in the use of the natural resources (through rent or purchase, for instance) such that in the long run we just observe efficient contract arrangements. These two considerations provide both a contractarian and evolutionary perspectives on institutional change (Knight, 1992)that might explain why and how there could be a switch to a higher efficiency contractual arrangement.

Consider though an alternative line of argument. Suppose that the Charter does provide a more efficient arrangement than informal cooperation. As setting up a Charter is costly, the situation is analogous to the voluntary provision of a public good, everybody would be better off with the Charter but nobody has an incentive to contribute to it. The larger the group the more difficult would be the provision of the public good.

Implication 4 (Population) (Alternative to Implication 2)

The larger the group the more severe is the free-riding problem of provision of a Charter. Hence, communities with a large population are less likely to adopt a Charter than small communities.

If the empirical result supports Implication 4 over Implication 2 then we have to deal more carefully with the problem of transitioning from informal cooperation to legal institutions. In the opposite case, the result would support the view that the *potential* gains of the Charters are a good predictor of its adoption. Moreover, it suggests that the transition to the more exclusive property right regime might not be a critical obstacle in this situation.

On a different note, the timing and location of adoption of the Charters might underlie a pattern of geographical diffusion (Figure 1). There are two distinct reasons to expect this outcome. According to one line of reasoning, it seems unlikely, because very costly, that a community of mostly illiterate peasants would set it up without a model. Imitation of other communities would instead be the driving force of the adoption. Only the availability of information about this legal institution and the proximity of a working example of it might have prompted a community to adopt it as a new management regime.

The second reason is the possibility that Charters, at least in part, were signaling devices to would be trespassers. The question is: did Charters increase surpluses in communities that initiated them because they diverted violations from their commons to other communities? That is, was the increased surplus in the Charter-establishing communities, at least partially, offset from declines in surplus from increased outsider infringement in non-Charter communities?[43] Distinguishing between these two reasons has important welfare implications.

Implication 5 (Contagion)

Because of the lower cost of imitation compared to original innovation and because of the deterrence effect induced on trespassers, a community is more likely to adopt a Charter when nearby communities have already adopted it.

[43] In this sense, the role of the Charters may resemble to the role that home security systems play in neighborhoods where warning stickers at entry points deter thieves, but encourage them to make a break in somewhere else without security devices.

8. EMPIRICAL ANALYSIS

Probit model of Charter adoption. Our statistical procedure relies on an event history model to explain why a community has adopted or not a Charter (1 or 0 value) in a given time interval. This methodology can handle two issues present in the data set, censoring and time-varying explanatory variables (Allison, 1984). Censoring occurs because the period considered is finite and the event of a Charter adoption does not occur for all the units. Time-varying explanatory variables such as if a neighboring community has already adopted a Charter could be relevant before the community itself adopts the Charter but not after that event. The observations relevant for this analysis are those in the risk set, meaning the set of communities who have not adopted a Charter at each point in time. In practice, a community who adopts a Charter in the time interval t contributes to t observations. For a community, the event variable is 1 for the time interval of adoption t and 0 for all the previous (t-1) time intervals. No observations are included in the data set for that community for time intervals subsequent to t. The dependent variable in the event history model is the hazard rate, P(t), meaning the probability that a Charter will be adopted in the time interval to a particular community, given that the community have not adopted a Charter yet (it is at risk at that time). As P(t) is in [0,1], the estimation can be done with the following probit regression model:

$$(7) \quad \log \frac{P(t)}{1-P(t)} = a(t) + b_1 x_1 + b_2 x_2(t) + \varepsilon(t)$$

where, P(t) is (Number events in time interval t)/(Number of communities in the risk set in time interval t), a(t) is a time trend, x_1 represents time-invariant explanatory variables, x_2 represents time-varying explanatory variables, and $\varepsilon(t)$ are $N(0, \sigma^2)$ i.i.d..

We use a discrete-time model to explain the adoption of a Charter. The time unit is a 5-year interval. All the events are treated as exactly the same kind.

Regressors. The first adoption of a Charter by a community could be influenced by its remoteness, land ownership structure, and population of a community as well as by the previous adoption of a Charter by other communities both locally and in the region. A detailed description of the data sources is provided in the Appendix.

Remoteness is composed of at least three elements, linear and altitude distance from a local town and periphery with respect to the wider region. Remoteness is expected to be negatively correlated with the likelihood of adopting a Charter (Implication 1). Within the region, seventeen towns have been identified as local reference centers. They are the historical headquarters of the decentralized government administration. The distance between the community and the local center is the first dimension of remoteness. Another dimension is the altitude difference between the community and the local center. In a mountain landscape, the steepness of a path and not only its length can be related to how isolated a community is. The two dimensions are however strongly correlated. The third dimension refers to a community being at the borderline of the region.

Community population might be positively correlated with the likelihood of adopting a Charter (Implication 2) or negatively correlated (Implication 4). Systematic population data are not available at the community level except for 1810 (Andreatta and Pace, 1981, Consiglio provinciale d'agricoltura pel Tirolo, 1903). Consider however the following proxy variable. The community territory is first broken down into four parts, corresponding to four different productivity levels. At the highest level of productivity there is the most valuable land: vineyard, fruit garden, and plowland (L1). Then, at lower levels of productivity there are meadows (L2),

then forest, alp, and grazing land (L3), and finally wasteland, lakes, and ponds (L4). Under the assumption of constant relative prices and constant returns to scale, the agricultural production value of a community could be written as $\pi = \alpha_1 \cdot L1 + \alpha_2 \cdot L2 + \alpha_3 \cdot L3 + \alpha_4 \cdot L4$. We expect that $\alpha_1 > \alpha_2 > \alpha_3 > \alpha_4 = 0$. Under the assumptions that population is proportional to the agricultural production value and that the relative distribution of the inhabitants across the communities does not changed over time, π is a proxy for community size. As the exact weights α_1, α_2, α_3 are unknown and depend on relative prices of the outputs of different types of land, we ought to estimate them in the regression along with the impact of community size on the likelihood to adopt a Charter. In practice only L1 and L3 are in the regression because of the high correlation between L3 and L2 (0.84). The coefficients α_1 and α_2 are expected to be positive. In alternative to π, a trend for the Italian population is available (Bellettini, 1987), although its ability to capture the above effect relies on the auxiliary assumptions that the Trentino region behaves like an average Italian region. Because of the strong assumptions we have made, both proxies for population, one based on land value and the other on the national trend, are only partially satisfactory. Given that data for community size are available for the year 1810, a more direct test can be performed for that point in time. Results are similar.

The amount of commonly owned resources is expected to be positively correlated with the likelihood of adopting a Charter (Implication 3). Holding other factors constant, in particular community population and relative prices, a higher extension of collective resources implies a bigger stake for the community in managing the commons. The proxy for the extension of common land is the sum of forest, alp, and grazing land in the community territory, which coincides with the variable L3 above. A detailed analysis of the 1790 land registers of two communities has revealed that L3 land was almost entirely common property (Goio, 1978,

Varesco, 1981). If there is a fixed cost in creating and maintaining a Charter, it would never be optimal to adopt it if below a given threshold of common resource endowment. To capture this possible non-linear effect of the variable L3, a dummy is created which is 1 for values of L3 above the median.

The likelihood of adopting a Charter could be positively correlated with the previous adoption of a Charter by other communities (Implication 5). Consider a model of contagion, where the dynamic is governed by a logistic function: $Dx(t)/dt = rx(t)((1-x(t))/K)$, where $r, K>0$ and $x(t)$ is the number of community who have already adopted a Charter. The cumulative number of charters, $x(t)$, is an S-shaped function of time. The regressor is the number of communities with a Charter in the previous time interval as the variable to be explained is $P(t) = (dx/dt)/(1-x) = rx/K$. We study the effect of three different sets of communities: the whole region and two distinct subsets of neighbors. Regarding this latter specification, to capture the effect of neighbors adopting a Charter one can consider a partition of the region in clusters or a community-specific measure of physical closeness. First the region was divided into 89 non-overlapping and exhaustive clusters of communities and considered the adoption of a Charter within each cluster. This partition is the 1800 administrative districting of Trentino. The regressor is a dummy variable indicating whether that there is at least one community in the cluster that has adopted a Charter by the previous time interval. The second version of neighborhood is the set of communities that shares borderlines with the community itself. Once the set of neighbors is identified, we build a dummy variable indicating whether at least one neighbor has adopted a Charter in the previous time interval. This last variable closely measures the impact of a Charter as a signaling device.

Because of high correlations we cannot test together the regional and the physical neighbor proxies.

Other regressors include four dummies for important historical events that might have influenced the adoption of a Charter: the Black Death (from 1350 to 1400), the Peasant War (1525-1535), the Council of Trento (1545-1565), and the Italian crisis of the first half of the XVII century (1600-1650).

Summary statistics. For each time interval, the data set indicates whether a community has already adopted a Charter. A total of 231 communities are included in the regressions. In 26 instances a group of villages formed a single community and wrote a common Charter. In that case the villages are consolidated into a single community and the information about the individual villages are dropped from the data set. Moreover, 8 communities were excluded for reasons due to difficulties to interpret Charter data and for being the major city in the region (Trento). The Charters date from 1202 to 1795 and by the end of the period about 61% of the communities had a Charter. The period from 1200 to 1800 is divided into 120 time intervals of 5-year.[44]

Point estimates of the event history model. In order to check the robustness of the results and to avoid using highly correlated regressors in the same estimation, we present three different specification (A), (B), and (C) of the probit model (Table 2). Specification (A) is a nested model of specification (B), while (C) is a variation of (A) in relation to population and contagion variables.

The probability of adopting a Charter significantly increases with the remoteness of the community, measured as distance from the local town. The other dimensions of remoteness,

[44] A 10-year interval specification yields similar results.

altitude difference from the local town and being at the regional border, does not appear to play a role.

The larger the community in terms of population the more likely it is to adopt a Charter. In specification (C) we have estimated the impact of the national population trend (time specific but not community specific) and of the population proxy based on land value (not time specific but community specific). Notice that the estimated coefficient ratio $\hat{\alpha}_1 / \hat{\alpha}_3 \approx 17 >> 1$ reflects the higher productivity associated to vineyard, fruit garden, and plowland (L1) in comparison to forest, alp, and grazing land (L3). A more direct test on the impact of community size will be performed for the year 1800.

Communities with wider possessions of common land are more likely to have a Charter. This conclusion is supported by the positive and significant coefficient of the dummy, which is one when L3 is above its median value. The coefficient of the variable L3 is consistent with an effect of common land size on Charter adoption but would not alone be conclusive because, as already explained, it is also a proxy for population along with L1.

The presence of other communities with a Charter significantly raises the likelihood of a community to adopt a Charter itself. All three proxies of contagion have an impact, regional, local, and neighborhood diffusions. Alternative interpretations are compatible with these results. On one hand the diffusion of a Charter as a legal innovation might be related to the spread of information and lower costs of the legal procedures to adopt one (specification (A)). On the other hand, the explanation might mostly rely on structural variables such as the reaction to the better protection strategy of a neighbor.

Although all the signs are correct, of the historic specific dummies that might have slowed or sped up the adoption of a Charter, only the Council of Trento have any significance impact (specification (B)).

Point estimates for 1800. The availability of community-level population data make it possible to run a direct test of the impact of population on the probability of adoption of a Charter. The results are presented in Table 3. The probit regression includes all the regressors from specification (A), which are not time specific. Furthermore L1 and L3 are highly correlated with the population variable and are not included. Such correlation confirms that L1 and L3 were reasonable proxy for population in the previous model. The results confirm the main findings. The only puzzling piece of result is the negative value of the coefficient of the contagion variables.

9. CONCLUSIONS

We have carried out a theoretical and empirical analyses of two options for managing common property resources, namely informal cooperation through repeated interaction and legal institutions, in the form of Charters, in the context of community governance of forest and pasture in the 13^{th}-19^{th} century Italian Alps.

One part of this study outlines the framework of analysis and the other part carries out an empirical test on the emergence of community Charters. In order to better understand the empirical findings we first summarize the framework.

Instead of viewing informal cooperation and the adoption of a Charter as antithetic solutions to the overexploitation of the commons, this paper suggests that one option can complement the other. In particular, in a context where actions could not be perfectly observed and where

enforcing property rights was costly, informal cooperation might still had been possible but institutions – especially legal institutions – could improve efficiency in the use of common resources in the following three ways.

First, by building community ties through restricting immigration into the community, controlling trespassing on the common land, and increasing the cost of moving out of the village. These provisions had two aims: (1) drawing a line between insiders and outsiders and reserving to the insiders the exclusive right to use the local forests and pastures, and (2) shaping property rights on the common land to promote a long-term relationship among insiders. Ensuring long-term interaction was a tool to better enforce internal norms in a context where state courts were too expensive to use. We argue that the communities decided on this latter self-closure measure as a consequence of the poor law enforcement services offered by the state.

Second, the efficiency of informal cooperation was enhanced by institutions that actively gathered information and shared it within the community. As information about resource use becomes more accurate and is made public, the efficiency of resource use can be increased. In fact, once external property rights on the common resources are legally well defined and enforced and once insiders face a continuing relationship, informal cooperation can be better sustained the more each insider can precisely assess the cooperation level of the others, so that he could decide whether to keep cooperating or to switch to punishing.

Third, by introducing a superior punishment technology to discourage free-riding by insiders. The legal sanctioning system adopted was less wasteful than the standard informal system to punish ("price war") because (1) it avoided deadweight losses, and (2) it targeted the individual free rider. There were other means to punish as effectively but legal sanctions were more efficient than alternative systems.

Using data about three hundred villages, we tested the impact of four factors in the emergence of community Charters, namely remoteness, population, commons size, and contagion. The findings can be summarized as follow. First, the more accurately a user can observe the cooperation level of the other legitimate users - for instance because overuse cannot be due to outsiders' thefts - the higher can be the surplus from a repeated game solution (Implication 1). The communities with lower risk of external trespassing, because more distant from towns and communication routes, are found to be the less likely to adopt a Charter. Second, the more difficult it is to coordinate on a common implementation of punishment for resource overuse, the lower is the surplus from a repeated game solution (Implication 2). More precisely, larger communities in terms of population face a higher risk of coordination failure and, as it turns out, more frequently adopt a Charter. This result runs contrary to what one may conjecture, namely that group numerosity might be an obstacle in building a costly public good like a Charter (Implication 4). Third, given the fixed cost to build and run a legal institution, communities with a small endowment of common property might find more appealing to rely on a repeated game solution (Implication 3). The empirical analysis highlight that Charters are more frequently adopted in communities with a higher-than-the-median endowment of common property. Fourth, the location and timing of diffusion of the Charters seem to be correlated with the presence of neighbors who already had Charters. This contagion effect could be due either to the lower cost of imitation compared to original innovation or to a response to negative spillovers from neighbors with a superior enforcement technology (Implication 5).

Appendix: SOURCES OF DATA

COMMUNITY CHARTERS (*Carte di Regola*)

Unpublished sources: The original manuscripts are kept at several archives: Biblioteca Comunale di Trento, Archivio di Stato di Trento, Archivio della Curia Arcivescovile di Trento, Biblioteca Civica di Rovereto, Ferdinandeum Museum of Innsbruck, Archivio di Castel Bragher (Coredo, Trento), and in village archives. Casetti (1961) provides a basic guide to the Trentino archives. *A list of unpublished manuscripts currently available in the archives has been kindly supplied by Marco Stenico of the Department of Sociology of the University of Trento.*

Published sources: About 190 of these Charters where published in Giacomoni (1991). Many other publications have published just one Charter. An exhaustive list of such articles and books for the years before 1988 is given in Nequirito (1988) while for the years after 1988 a list can be provided upon request.

Dataset: We have collected information for 356 Charters from both published and unpublished sources. Of them, the text was found for 265 Charters while only the news of their existence is available for 91 Charters. They refer to 224 different geographical units, although there are instances of a Charter referring to a group of villages and villages within the group having a distinct Charter. The present study focuses only on the first adoption of a Charter by a village. Some Charters are newer versions of a first draft.

LAND REGISTER DATA (*Dati catastali*)

Year 1780, Unpublished: A collection of manuscripted books recording property rights on land can be found in the Archivio di Stato di Trento under *Serie Catasti Teresiani*. It comprises one or more books for each village (*comune catastale*) and describes in a systematic manner all parcels of land in the region and records the owner.

A detailed data analysis of the books for the village of Levico was done in Goio (1978). An analogous analysis for the village of Predazzo was done in Varesco (1981).

Year 1897, Published: Consiglio provinciale d'agricoltura pel Tirolo (1903). The original sources of the data are land registers. Land registers are not the *Catasti Teresiani*. A new survey was carried out in the mid nineteenth century with new criteria and in addition to the books maps were drawn up (*Mappe Napoleoniche*). The 1897 land register partition of the region is taken as reference for the community Charter analysis. The region is divided into 392 geographical units which with a handful of exception is always a finer partition that the community areas of the Charters. The regional statistics brought from this source consider an area of 6,356.33 squared km that is 2.4% greater than the current area of the province of Trento.

*Dataset: For each of the 395 geographical units (*comune catastale*) the data set reports village surface devoted in 1897 to plowland, meadow, fruit garden, vineyard, grazing land, alp, forest, lake or pond, wasteland, houses, and total surface in hectares (10,000 squared meters).*

POPULATION DATA

The 1810 village level data used in the regression are based on the data reported in Andreatta and Pace (1981). In the instances where a finer partition was necessary, the 1810 figure was divided proportionally to the 1897 figures, which are published in Consiglio provinciale d'agricoltura pel Tirolo (1903).

NEIGHBORING COMMUNITIES

Partitioning of the region: based on the 1810 administrative division of Trentino described in Andreatta and Pace (1981).

Physical bordering: reconstructed using land register data and GIS maps kindly provided by dr. Filippo Militello, Director of the Ufficio Catastale di Fondo (Trento).

COMMUNITY INTERNAL ADMINISTRATION

Unpublished:

Libretti d'Amministrazione [della Comunità di Mezzolombardo], *series of booklets of the years 1589, 1652-1699, 1718-1797, manuscripts, Archivio Comunale di Mezzolombardo, province of Trento, Italy*

Libro de' Conti dei Regolani della Honoranda Comunità di Coredo, *series of booklets from 1635-36 to 1698-1699, manuscript, Archivio Comunale di Coredo, province of Trento, Italy*

Published: Delugan and Visani (1988), Valenti(1911), Papaleoni (1891, 1893), and Dossi (1913, 1927) describe aspects of the property rights structure on the land.

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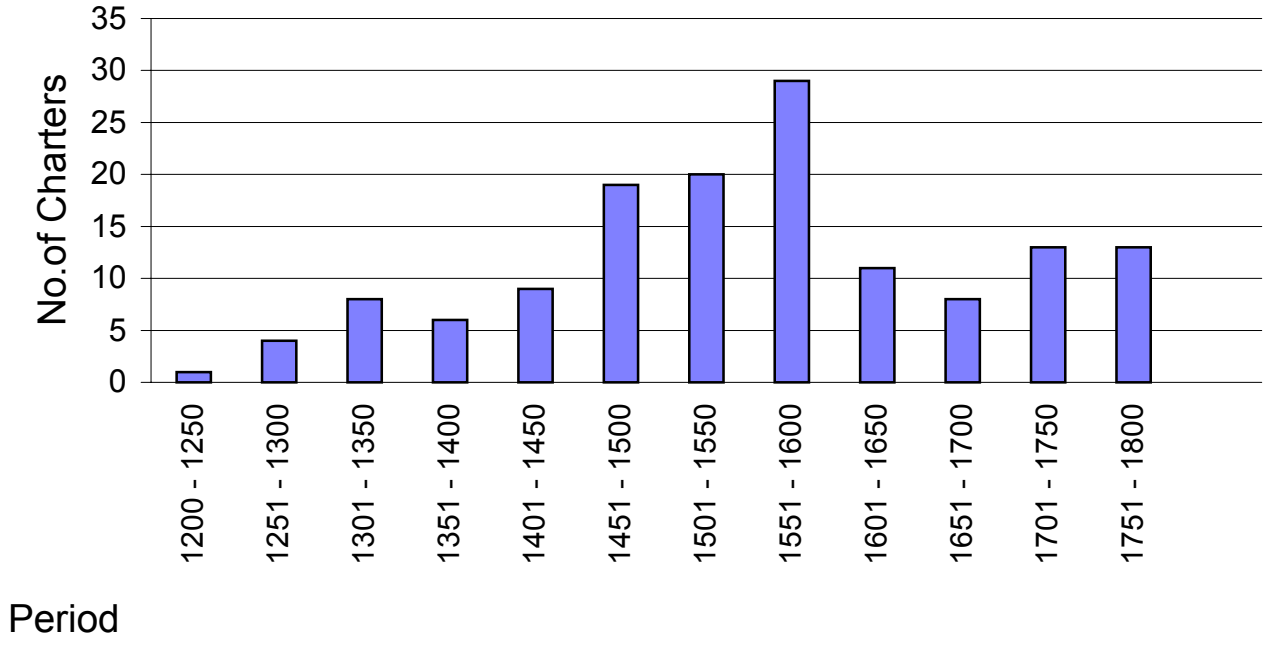

Figure 1: Time profile of first-time Charter adoption

Table 1: Summary statistics

	Mean	Std. Dev.	Min	Max
Have adopted a Charter (dependent variable)	.006759	.0819369	0	1
Remoteness - Linear distance from local town (kilometers)	7.755525	5.940021	0	25
Remoteness – Altitude difference from local town (meters)	221.4687	208.0693	0	962
Remoteness - At regional border (dummy)	.1968266	.3976097	0	1
L1 (vineyard, plowland, fruit garden) - hectares	168.0966	240.6694	4	2143.6
L2 (meadows)	131.3872	250.6875	0	4292.2
L3 (forest, alp, grazing land)	1452.406	2445.843	8	36980
L4 (wasteland, pond, lakes)	274.2787	650.6639	2.5	5204.5
High endowment of common resources – (dummy for L3 above median)	.4972916	.5000046	0	1
Community size - Italian population (millions)	10.78374	2.163113	8	18.1
Contagion - Number of Charters adopted in the region (lagged)	45.3646	44.72522	0	143
Contagion – There is at least a community with a Charter in the same cluster (lagged)	.2450985	.4301559	0	1
Contagion – There is at least a physical neighbors with a Charter (lagged)	.5134941	.4998299	0	1
Black death (dummy)	.1029193	.3038608	0	1
Peasant war (dummy)	.0162504	.1264401	0	1
Council of Trento (dummy)	.0312066	.1738797	0	1
Crisis of first half of XVII century (dummy)	.0631801	.2432924	0	1
Community population in 1810	704.769	1029.454	46	9478
Number of observations	20861			

Table 2: Charter adoption analysis

Specifications:	(A)	(B)	(C)
Dependent variable: First adoption of a Charter by a community in a specific time interval			
Independent variables:			
Remoteness - Linear distance from local town	-.016226 ***	-.0162738 **	-.0142691**
	(.0056624)	(.0064848)	(.0056414)
Remoteness - Altitude difference from local town	–	.0000075	–
		(.0001879)	
Remoteness - At regional border	–	-.0055689	–
		(.0807722)	
L1 (vineyard, plowland, fruit garden)	.0003361 ***	.0003363 ***	.0002877 ***
	(.0001057)	(.0001057)	(.0001042)
L3 (forest, alp, grazing land)	.0000199 **	.0000195 *	.0000168 *
	(.0000097)	(.00001)	(.0000099)
High endowment of common resources –	.2022705 ***	.202356 ***	.1861799 ***
(dummy for L3 above median)	(.0717361)	(.0720354)	(.0720493)
Community size - Italian population	–	–	.0461322 ***
			(.0144408)
Contagion - Number of Charters adopted in the	.0043943 ***	.0044 ***	–
region (lagged)	(.0007782)	(.0008096)	
Contagion – There is at least a community with a	.2142596 ***	.2134901 ***	.1967932 ***
Charter in the same cluster (lagged)	(.0724821)	(.0728263)	(.0729857)
Contagion – There is at least a physical neighbors	–	–	.2998076 ***
with a Charter (lagged)			(.0833133)
Black death	–	-.1114078	–
		(.142484)	
Peasant war	–	-.3124285	–
		(.3296603)	
Council of Trento	.2771163 **	.2544837 **	.2445293 *
	(.1301566)	(.1308995)	(.1305277)
Crisis of first half of XVII century	–	-.1213277	–
		(.1205792)	
Constant	-2.909707 ***	-2.886687 ***	-3.357298 ***
	(.0830009)	(.0879589)	(.1688388)
Pseudo-R^2	*0.0625*	*0.0640*	*0.0634*
Number of observations:	*20861*	*20861*	*20861*

Notes: Event history model, probit regression. Standard deviations in parentheses. No pair of regressors in the same column has a correlation 0.50 or higher with the exception for specification (B) of linear distance and altitude difference from local town (0.54). Significant at * = 10%; ** 5%; *** = 1%.

Table 3: Charter adoption analysis for the year 1800

Dependent variable: First adoption of a Charter by a community by 1800

Independent variables:

Remoteness - Linear distance from local town	-.0958828 ***
	(.0272674)
Community Size – 1810 community population	.0007818 **
	(.000307)
High endowment of common resources - (dummy for L3 above median)	.5735643 *
	(.3417688)
Contagion – There is at least a community in same cluster with a Charter (lagged)	-.1885171
	(.3244279)
Contagion – There is at least a physical neighbors with a Charter (lagged)	-2.054074 ***
	(.6768443)
Constant	2.335505 ***
	(.7382044)
Pseudo-R^2	0.1633
Number of observations:	231

Notes: Probit regression. Standard deviations in parentheses. Significant at * = 10%; ** 5%; *** = 1%.