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A social-leverage mechanism on the Silk Road: the private emergence of institutions in central Asia, from the 7th to the 9th century

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Abstract. We explain archaeological evidence of *Sogdian* merchants in central Asia in early medieval, remote long-distance trade on the emerging Silk Road. In fact, it began as barter, but was based on the social organization that Sogdians developed in their communities when migrating east. Their particular way of generating trust and institutionalized cooperation was by social leverage, involving third parties as contract witnesses and/or guarantors. These usually had own commercial relations with the contractors, facilitating crediting and exchange – and credible threat to defectors. While Greif (1989) had been criticized for overlooking courts in the Maghribi case, we discuss a differentiated (latent) role for courts. We also discuss property rights *versus* possession, transactions costs and price implications. We analyze the mechanism in historical cases and game-theoretical reconstructions, and explain trade flourishing under strong uncertainty.

1. Introduction

The early-medieval trade on the European–Asian Silk Road, perhaps the most important inter-continental and inter-cultural trade route in those times, contributed much to the cultural exchange and economic development of the Mediterranean area, Central Asia, and China (e.g., Elisseeff, 2000). When foreign traders encountered each other on such long-distance routes, and particularly in those (then) remote central Asian areas, neither family and kin ties nor a common ethnicity and culture nor a formal legal-power background (state, courts, police/military, or currency) were existent yet to sustain sufficient trust, commitment, and cooperation for the trade to emerge and the Silk Road to get completed. Sufficient trust and institutionalized cooperation would have been required to make agents deliver any advance goods or service and to possibly

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wait for many months, sometimes a year or two, to receive their equivalent performance. In the absence of any such enforcement, formal or informal, uncertainties would have encouraged opportunistic behavior in such collective-good or social-dilemma settings (e.g., Elsner and Schwardt, 2014; Greif and Mokyr, 2016; North, 1981), and trade could not be expected to take off, as it in fact did. Institutionalized cooperation must, under such conditions, have emerged through some particular *private mechanism*.

A number of case studies in economic history, together with some formal, mostly game-theoretic, reconstructions, have become bridge builders among economic history, theory, and formal modeling in the last couple of decades. For instance, the relational contracting among *Maghribi* merchants and their overseas agents in the medieval Mediterranean trade is well known (e.g., Greif, 1989). Overseas agents and Maghribi merchants were modeled as parts of a principal-agent problem in that trade. The contractual problem did involve here, too, that 'agency can't be solved neither by the legal system nor by the market' (ibid: 858). It was solved by forming a reputation mechanism of overseas agents and Maghribi merchants, collectively punishing any agent infringing their collaborative commercial code. Likewise, Milgrom *et al.* (1990) argued that repeating interactions could be analyzed as a factor supporting trade in *Europe* during the 12th and 13th centuries. They concluded that community enforcement was established without common formal institutions, which in fact did not exist yet. So, historical cases and their theoretical analyses have offered *relational mechanisms* established to overcome trust and contractual problems, when long-distance trade emerged in legal voids.

Turning to another important historical case, the early and very long-distance trade on the *Silk Road* in central Asia during the 7th to 9th centuries C.E., this paper adds to the existing literature a particular relational and 'reputational' mechanism among alien merchants, which we call *social leverage*. Different cases may require a somewhat different model and theorizing, as Hodgson (2002) emphasized with respect to historical analysis in economics and the problem of historical specificity.

We reconsider archaeological documents, already well known to historians and political and legal scientists, and formally reconstruct the social leverage with a game-theoretic model. The historical records refer to the so-called *Sogdian* merchants and their role in establishing trade from central Asia to, and even within, China.

Other than Greif (1989), we explicitly discuss the latent role of *courts* and find a differentiated relevance of courts for private *versus* criminal law issues (i.e., different for contracts than for possession rights). Brief theoretical discussions will also include *property versus possession rights*, *transactions costs,* and *price implications*, and the eventual sudden end of the Sogdian 'connection' to China, in times when the land-borne trade had to give way to an emerging maritime Silk Road.

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The paper proceeds as follows: The second section sets out the trust and cooperation problem for the trade in the remote areas and long distances of central Asia of that early time of the Silk Road. Section 3 describes the social-leverage mechanism in some historical cases. Section 4 provides a formal reconstruction of that mechanism and identifies some conditions of trust and institutionalization of cooperation. Section 5 generalizes conditions for private mechanisms for nowadays and concludes.

2. The particular uncertainty in the remote parts of the early Silk Road – and the social organization of the Sogdian merchants

Origins of the sogdians

Sogdia, people of Iranian origin, speaking the Sogdian or Iranian language, are considered to have emerged in the *Samarkand* and *Bukhara* regions, in today's areas of Uzbekistan and Tajikistan in central Asia (see map, Figure 1 below). Sogdian religious beliefs are considered to have been diverse: Zoroastrianism, Buddhism, Hinduism, and others, but most of them were Zoroastrianists (e.g., Grenet, 2007). Historically, Sogdian activities are divided into three periods, the Achaemenid, Hellenistic and '*Silk Road*' *periods*. Their culture reached a peak in the early Silk Road period, reflected by increased intercultural exchange and their monopolization of the central Asian trade. In their Silk Road period, 7th–9th century C.E., the Sogdian merchants were the most important merchant group on the Silk Road (e.g., Henning, 1948: 8). They generated a considerable economic performance and virtually monopolized the commerce with China, not the least through their strong social organization and their social-leverage contracting.

The historical records from the Silk Road

Five of the most important documents of the Sogdian history, so-called *ancient letters*, discovered by Aurel Stein, a British archaeologist, in a Chinese watchtower just west of the Jade Gate near the city of *Dunhuang* (see map, Figure 1; also, e.g., Yamamoto and Ikeda, 1987, who spell it Tun-huang) in 1907, provide extensive information about the social life and commercial activities of these merchants (e.g., Hansen, 1995). Together with documents from the city of *Turfan* (map) during the *Tang Dynasty* (618–907 C.E.), they provide a detailed picture of socio-economic mechanisms employed, under conditions of fundamental uncertainty. The *Turfan* documents, a series of trade contracts reflecting social and business mechanisms in the *Turfan* oasis, serve as excellent documents of the Silk Road trade at that time (e.g., Hansen, 2010).

Uncertainties in early medieval long-distance caravanning

Inter-cultural long-distance trade in early medieval times was generally characterized by much uncertainty regarding the quality of goods, fluctuation of

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Figure 1. (Colour online) The Europe–China Silk Road in the 7th–9th centuries C.E.

prices, and length of time of delivery (e.g., Greif, 1989: 860). Sogdian merchants carried valuable and rare goods, such as gold, silver, brass, ammonia, medicinal plants, or perfumes (Vaissière, 2005), traded by them as intermediary merchants. They spent particularly long times on their routes, sometimes walking thousands of miles, from central Asia to the Tang region (e.g., there are 3,000 miles between Samaragand and Luoyang). The preservation of non-durable goods was only one particular problem; arrival times in general, were difficult to estimate, as they were dependent on weather and road conditions, assaults on the way, etc. Thus, also the exact final prices of the goods were uncertain at the destination – if goods were not traded anyway several times on the way.

The eastern spread of the Sogdians and their social organization in the diasporas

Around 300 C.E., Sogdian merchants began to push their domain gradually from their original Persian communities east to China and into the city of *Luoyang* (map). However, their main activities were concentrated close to the western border of China, in the city of *Turfan* (Hansen, 2010: 2). During that time, also other foreign merchants became (temporarily) residents of Turfan, but most of them were Sogdians (e.g., Skaff, 2003: 476). These increasingly dominated the trade with China after 300 C.E. (Henning, 1948). And the social organization in their diasporas became crucial.

It can be seen from the records that Sogdian merchants were esteemed and considered nobles in the Tang Dynasty: First, because of their custom of *gift exchange*. They swapped precious goods (e.g., golden pots and spices) with the Tang government in return for (mostly) silk, a custom which established and sustained privileges for them. In *Chang'an* (map) and *Luoyang*, the courts continuingly received gifts from Sogdian cities, including, e.g., 'golden peaches' (made of gold) of *Samaragand* (now Samarkand; map), various medical herbs, carpets, indigo, gold, objects embellished with jewels, coats of mail, etc. (e.g., Vaissière, 2005). This indicates that Sogdian merchants were rich and had good relations with the Tang system (e.g., Dohi, 1988: 420). Second, Sogdians not only exerted influence on general Chinese officials, but also engaged in Chinese political and military affairs. That went even as far as some rebellion eventually, led by a Sogdian general in Tang military service, An Lu-Shan, which may have ended the Sogdian period (e.g., Pulleyblank, 1955: 5; more below).

The Sogdian *ancient letters* mentioned showed that already in the 4th century, Sogdian communities existed in *Dunhuang* and *Luoyang* (e.g., Skaff, 2003: 476). Sogdian established religion-based communities, particularly based on Zoroastrianism and officially called *Sabao* in the Tang system, which supported the long-distance caravan trade and facilitated Sogdian expansion into China (e.g., Feng, 2001; Sims-Williams, 1996; Vaissière, 2005). None of these communities was a simple sum of individual merchants, but was organized hierarchically (Vaissière, 2005). When the number of Sogdians in a community

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reached around hundred households, they built a Zoroastrian temple and formed a Sabao (Hansen, 2003). The *small size* of a Sabao supported *group identity* and an atmosphere of *trust*, which could be maintained even when moving to a new place (Hansen, 2010). These communities were in fact rather 'closed', due to the same religion and social behaviors. Such 'closure' usually helps maintaining identity and reputation through the limitation of membership and a clear definition of its borders (e.g., Coleman, 1990: 219). The Tang government even entitled the Sabao system to self-administer their daily affairs and punish deviating behaviors (Ikeda, 1981).

The Tang Code denying legal court enforcement for private contracting

Trade on the Silk Road was inter-continental and inter-cultural exchange of goods between the western world and the Tang domain of East Asia. In the *Turfan* documents, 250 out of 1,600 contracts show signatories that were not Chinese, of which most were from Sogdian merchants (Hansen, 1995: 44; Yamamoto and Ikeda, 1987: 29). But all contracts were *not mainly enforced by the legal system of the Tang state*. This can be inferred, on the one hand, from the legal framework of the Tang state, the Tang Code (e.g., Hansen, 2003, 2005, 2010).

In contrast to the general recognition of the Sogdians in Tang China, Tang officials had to avoid meddling with private contracts, according to the Tang Code. When officials and private individuals lent money or goods, the transaction was officially *considered purely private*, and officials would not intervene, as long as two conditions were met: First, the interest charged would not exceed 6%, and second, the cumulated interest payments would not exceed the value of the original item, independent of how much time had passed (e.g., Gernet, 1957: 299f.; Hansen, 1995: 43; MacCormack, 1985: 46f). Therefore,

> people drawing up contracts did not anticipate going to court. All of the Turfan contracts describe ideal scenarios in which purchasers are able to come up with the money [. . .] and in which debts will be repaid (Hansen, 1995: 44).

But that ideal presumption, of course, very often was not reality (e.g., Yamamoto and Ikeda, 1987: 29). So, obviously, there was a massive requirement, given that *particular high level of uncertainty*, to provide a *private enforcement* mechanism for contracting, since this might easily have made the Silk Road trade entirely impossible.

Thus, while courts did exist, they were hardly considered an enforcement reducing the uncertainties in private transactions by the private agents. According to the reluctant Tang Code, the contracts discovered in *Turfan* often said 'Office has government law and do not accept private agreement as conclusive' (Ikeda, 1981: 78; see also further below). Although the merchants were not completely unable to invoke the courts, and perhaps could take it *as a last resort*, they

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would not have expectations to solve their uncertainty problems in court, when the contracts were signed.

In *Greif*'s (1989) original *Maghribi* traders' case study and model, the existence of state courts was completely neglected, and monitoring and enforcement were allegedly performed solely by the traders themselves. However, courts did exist in the Maghribi world and, in fact, were used as a last resort (e.g., Goitein, 1988: 303). Greif's work was criticized for overlooking this fact, as already the mere existence of courts would probably have shaped the incentive structure of the private agents. Thus, here we try to briefly specify this important institutional detail for the case of the Silk Road transactions.

In the Silk Road records, there is little evidence indeed that the parties appealed to the courts in the *core questions* of the contracts, i.e., the trade business as such. Examples of going to court for solving transaction problems among merchants are truly rare in the *Turfan* documents. The relatively few cases where courts were invoked are those where *criminal issues* emerged, such as when unclear or mock property rights transpired.

Thus, the situation we may imagine is that agents did have a *consciousness of the existence of courts as a last resort*, but less so in the core aspects of contracts and more in the more extreme issues of criminal aspects transpiring. In the *Turfan* documents, we can find some court cases such as whether possession exchanged would be legal or not, for example, whether girls exchanged would come from common people or not.

Having specified the Silk Road case this way, we must leave it to future research on other historical and/or geographical cases to provide further evidence about the more or less tacit role of courts in a mainly privately governed business culture.

However, we will specify a formal criterion in the formal model below of when the existence and invoking of courts may change incentives and decisions of private agents, even under a predominantly privately governed contract culture (see section 4).

Lack of money, and barter trade as further particular sources of uncertainty

However, Sogdian merchants were facing even more severe uncertainty, beyond the conditions of traveling and the lack of legal court protection, further arising from the asymmetric information endogenous to bartering. Barter trade always comes into being, when there is *lack of money*. This, in fact, appeared in the Tang dynasty: Although the Tang government issued large amounts of copper coins to meet the commercial needs, a big gap was left for long periods – not the least, perhaps, due to the rising transcontinental trade carried by the Sogdians. While illegal mints began to issue those coins too, major price fluctuations and thus an additional uncertainty emerged, which might have easily restrained trade further (e.g., Hansen, 1995). Thus, the early central Asian Silk Road trade largely had to remain bartering.

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Barter, obviously, causes particular commitment and trust problems. It required that *several parties got involved* as one-to-one bartering could rarely meet the needs of both parties simultaneously. So the trade usually involved *crediting*, *brokering*, and *multilateral agreements* (circular trade), in order to work smoothly and facilitate goods exchange at all.

Many *Turfan* documents, for instance, are about the money lender *Zuo Chongxi*, showing that debt and credit always were involved because the lack of money. In these cases, the merchants had to *commit on the quality* of the commodities that would have to be returned *in the future*. *Asymmetric information* thus more or less applied to all goods traded, particularly when credit and future delivery was involved. The opportunism problem, obviously, was considerable.

Prohibitive transaction costs and cost/price impacts?

In all, and as indicated before, the level of general uncertainty might easily have cumulated so that transaction costs would have become prohibitive against any trade emergence in the early remote parts of the later Silk Road. But this, obviously, did not occur. From the Tang records, rather, we can see that only few contract documents indicate mechanism costs at all. For instance, contracts rarely mentioned any claims of guarantors or witnesses, which indicates that approving a contract would *not involve payments for guarantors and witnesses*. Because of the weak evidence, however, we cannot generally presume that guarantors/witnesses did not make some profit from social-leverage contracting, which in turn would raise costs and prices of traded goods and services. This might especially explain the *relatively high interest rates* in the cases of crediting involved, considerably deviating from the prescriptions of the Tang Code, which, in turn, presumed intra-Chinese safer situations.

Economists, different from historians and law researchers, still have made little investigation into these rich documents, and this particular space-time case of the Silk Road has not been fully explored in economic history yet. But for this paper, we may assume that transaction costs were '*endogenized*' *in the strong expectations of future cooperative interactions among all involved* in a specific contract. So we will not explicitly model transaction costs (more below).

A first generalization: the barter dilemma on the early remote Silk Road

For a more logical, formal analysis, a game-theoretical mapping seems appropriate, as exchange (under 'imperfect' conditions, compared to the neoclassical standard model) can be represented as a prisoners' dilemma (PD) (e.g., Hardin, 2006). We apply the usual terminology: R, reward for mutual cooperation, P, punishment for mutual defection, and S, sucker's payoff, T,

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temptation to defect, both for one-sided cooperation and defection, resp.:

$$\begin{array}{ll} R,\ R & S,\ T \\ T,\ S & P,\ P \end{array}$$

where $T > R > P > S$.

The dilemma structure for the merchants on the Silk Road, with both *court enforcement and legal money missing*, was particularly strong: *Asymmetric information*, and thus fundamental strategic *uncertainty*, was ubiquitous in the bartering over long distances and long time periods. So it would have to be expected that cheating, exploitation, and free-riding strategies, i.e., defection, would dominate cooperation strategies (thus in all, in fact, a PD). Any spontaneous, decentralized, anonymous, arm's length system with just price-coordination (a '*market*') would have been *locked-in* in the basic collective-good problem, where trader *A* could not have been excluded from the benefit, if trader *B* would provide his good or service. Such non-exclusion would have made trade infeasible.

Without a *private informal institution* to justify *trust* and thus to enforce *commitment* and *cooperation*, merchants would have known that any promise that goods will be delivered in proper quality and after an agreed period, would be dominated by incentives to defect. Accordingly, as is well-known, a 'commitment device' (e.g., Frank, 1987; James, 2002) is required in such settings. Pledges in terms of goods impawned would have been a 'commitment device'. However, they would have been extremely inconvenient in the long-distance trade, as caravans would have been overloaded with extra commodities to be used as pledge. So other 'commitment devices' were required.

3. The Sogdian merchants' social-leverage contracting

The *Turfan* documents indeed reveal the mechanism, by which the commitment problem was overcome by the Sogdians. They show that a specific, and *purely private*, arrangement was generated to support sufficient trust and cooperation. With the strong social organization of the Sogdian communities, as mentioned, an important social condition for such a mechanism to evolve did exist.

Examples of private contracting and trust generation

As an example, we consider a contract between a Sogdian merchant named *Kangwu Poyan*, who was not a resident in the Tang state, and a Chinese merchant, *Du* [] [first name not identifiable in the records]. *Du* [], an army leader in *Qianting* (about 45 kilometers southeast of *Turfan*), *Xizhou* area, offered 14 bolts of silk to buy a yellow camel, 10 years of age, from *Kangwu*. They agreed that once the camel and the cloth were exchanged, the transaction should be completed. If someone would make a claim to the camel later, it were up to

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Kangwu, and to the *guarantors to be involved* in the contract, to clarify or to provide compensation to the claimant, if so, and *Du* would not be bothered with that. But if the camel would not drink water or eat grass for 3 days, *Du* [] could return it to *Kangwu*. While the guarantors of the contract had not gathered yet, the contract was already drawn up. It was agreed that when they would be present, one would issue a certificate. So the contract was signed (Hansen, 1995: 40; Yamamoto and Ikeda, 1987: 29).

The contract did not make reference to legal enforcement, should one side fail to fulfill his obligation. Were the seller and guarantors really going to pay compensation in the case of third-party claims against the seller or buyer? Would the seller accept if the camel were to be returned? Although guarantors were required to provide compensation, if the contract would have been based on a wrongful claim of the seller: Criteria and amounts of compensation were not determined in the contract. Was this just neglect or naïveté, or was it warranted trust?

Generally, in fact, many private contracts would not have met the requirements of the Tang Code mentioned above: Some contract clauses were illegal or incomplete, implying that, even if they could have been brought to court, disputes were difficult to solve. So, obviously, contractors usually did not consider the court system at all.

Another contract dated 661 C.E. between the money lender mentioned, *Zuo Chongxi*, and a man named *Long Hainu* further illustrates such *incompleteness* and illegality of contracts. *Long*, resident of *Anxi* (map), received 30 bolts of bleached silk on credit from *Zuo*. The monthly interest agreed was four bolts (13.3%, more than double of the Tang Code limit of 6%). If the interest were not paid monthly, an extra fine of one bolt would have to be paid to *Zuo* for each month of arrears. Should the borrower abscond, it would be up to his wife and children, and to the *witnesses* or *guarantors*, whose names followed in the contract, to redeem his debt. The following put their finger prints (or finger joints) on the contract as a sign of good faith (Hansen, 2005: 51):

(1) contractor *Zuo Chongxi*,
(2) contractor *Long Hainu*,
(3) guarantor *Long Xu*,
(4) guarantor *Kang Wenxi*,
(5) witness *Wei Zuo*,
(6) witness *Fan Shide*.

Although the agreed interest rate would have been *illegal* according to the Tang Code, such practice was widespread in the *Turfan* records: *Interest rates* usually were 10% (Hansen, 2005: 52), perhaps some *reflection of a high level of uncertainty*. And the deviation from public law was deliberate. At the bottom of this particular contract was noted (For more details about part of these citations, you can refer to the Hansen (2005)):

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> Official has the government law, and the common people follow private contracts.

Similar clauses appeared in many contracts, sometimes even more clearly:

> Officials have government, while the people have their own ways (cited from Yamamoto and Ikeda, 1987: 2)

or

> Office has government law and do not accept private agreement as conclusive (Ikeda, 1981: 78).

It confirms that private contracts in the remote areas of the early Silk Road were largely independent of public regulations and did not expect public interference (including potential protection) based on the law.

A private mechanism in the absence of a public frame of reference, courts, or money

Historical analyses have confirmed that when informally institutionalized cooperation provides gains to both sides of an exchange agreement, such private-order institutions may indeed emerge (e.g., Greif, 1989). Since trust, commitment, institutionalized cooperation, and thus trade, increasingly flourished among the foreign merchants in that part of the early Silk Road, some 'private-order' mechanism, obviously, could successfully be established.

Variants of such 'relational' mechanisms to enforce private contracting in the absence of a public legal frame have been discussed in the literature. Some considered institutionalization of cooperation based on the *expected future value of the relationship* (e.g., Milgrom *et al*., 1990: 7). Some stressed already emerged, pre-existing institutions as a *normative framework* (e.g., Macneil, 1980: 4). Others emphasized the building and use of *reputation* (e.g., Greif, 1989). In fact, these variants are not particularly distinctive, as all such 'relational' mechanisms are based on *recurrent interactions in populations*.

The *Turfan* documents, particularly, suggest a *social-leverage* mechanism, where merchants conduct a transaction under the private enforcement of *guarantors* and/or *witnesses* involved, as mentioned. The Tang Code, in fact, reflected such practice, determining that a private contract needed to display five guarantors, or one guarantor and two witnesses for smaller exchange values. Guarantors and witnesses thus substituted pledges as commitment devices, when alien merchants met first.

For instance, in 731 C.E., the Sogdian merchant *Li Lushan* sold an 11-year-old girl to a Chinese resident of *Chang'an*, *Tang Rong*, for 40 bolts of silk (Hansen, 2010: 301). Four Sogdian merchants and one from *Tokharistan* (nowadays northwest Afghanistan) vouched, as witnesses and guarantors, that the girl was legitimate to be exchanged. As another instance, in 733 C.E., *Shi Randian*, a Sogdian, swapped a horse for 18 bolts of silk from *Kang*, another

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Sogdian. Three guarantors testified that the horse was not stolen. Two of the guarantors were even non-resident merchants, one of them from *Bukhara* (map) (see below on the issue of possession and property). But even if they were local residents, why would guarantors and witnesses trust the contract partners (and v.v.) and be willing to step in in case of doubt?

But as Skaff (2003) already mentioned, it is 'most likely [that] the guarantors were merchants who knew one another's business activity' (p. 510). They most likely had *business relationships with both contractors*, so that both trusted them, while the guarantors or witnesses trusted the core contractors.

One of the *Turfan* documents, concerning five merchants, particularly illustrates the relationship between witnesses/guarantors and contractors. That particular contract on credit, concluded in *Turfan* (Hansen, 2010: 292), involved:

(1) *Li Shaojin* (also called Li San), a *Chinese* merchant resident in *Chang'an* (or: Jingshi Han), borrower;
(2) *Cao Yanyan*, a *non-resident Sogdian* merchant, trustor;
(3) *Cao Lushan*, Yanyan's younger brother, resident in *Chang'an*, witness;
(4) *Cao Guoyi;* and
(5) *Cao Bisuo*, two *Sogdians*, *temporarily resident* in *Chang'an*, witnesses.

Evidently, all five were *non-residents* of Turfan, most of them residing in *Chang'an*, a very distant location (map). They contracted to execute some trade in *Gongyuecheng* (map), again a very distant location. The Chinese, *Li*, borrowed 275 bolts of silk from the Sogdian *Cao Yanyan*, and agreed to meet him later in *Kucha*, about 300 kilometers southwest (map).

Note again that the two contractors did *not even speak a common language* (Hansen, 2010: 293), but nevertheless concluded such a highly valuable contract, with *credit* and long distances involved. To appreciate the value of the contract, remember that a horse had a value of 18 bolts. But the witnesses each had commercial relationships with the contractors on their own and therefore would be willing to leverage that contract.

Such *mutual, circular or network-like commercial relations* are not particularly surprising, as evidence from the documents suggest that we are talking of a relatively *densely connected trade network* in that part of the Silk Road of probably only several hundred, and certainly but below 1,000 merchants (Rong, 1999). Given the *strong social structure*, as mentioned above, within the Sogdian (but also the Chinese) communities, with the Sogdians operating on both sides of the western border of the Tang state, a *reputation mechanism* could plausibly be established and operated.

Possession and property rights: private rule approval versus public law

A final remark is due on the formal/legal *versus* informally institutionalized/private conception of possession and property (for legal *versus* economic

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property in general, e.g., Hodgson, 2005). In our case, it again reflects and corroborates the particular '*state-free*' *environment of contracting* and trading on the early central-Asian Silk Road as already explained above. Examples of contracts above showed that 'possession' and 'property' (and related 'proper rights') were attested and 'legitimized' just by contract witnesses. For example, attesting possession, even of people, as 'legitimate' through the witnesses constituted a legal property for transaction in accordance with the Tang law. That is, with this private attestation, humans to be bought or sold were defined as slaves rather than common people. Should it turn out, however, that this was not justified, this would have been considered a criminal act under the Tang Code. So the law just constituted a rough frame, while 'property (rights)' could be constituted within private contracting.

A second generalization: multiple trade relations – multi-agent contracting

To generalize that social-leverage mechanism, consider the relations among the three types of parties of a social-leverage contract: (1) sellers (or creditors), (2) buyers (or debtors), and (3) witnesses and guarantors. (We do not make a particular distinction between witnesses and guarantors, although their economic/financial involvement was different.)

Consider a Sogdian merchant *A* and a Chinese merchant *B*, being about to conclude a contract, each having pre-existing commercial relationships with merchants *C*, *D*, and *E*. Under the prevailing adverse conditions – different cultural backgrounds, no common language, no legal reference frame or court support, no common money, long geographical distances, long time periods to bridge, barter relations, and some credit relation required – *A* and *B* may generate sufficient trust against each other only under the condition that both are sufficiently known by *C*, *D*, and *E* and expect future interactions with them. If *A* or *B* defect, *C*, *D*, *E* would be able to exert some additional '*second-order*' *punishment*, on top of the 'first-order' punishment that the cheated contractor might exert against the other. *C*, *D*, *E* might terminate future commercial cooperation, on their part, with either, *A* or *B*, and damage the defector's *reputation*. Such extra punishment, obviously, would be *costly* for *C*, *D*, and *E* in the same way as in the first-order punishment, and thus, would be subject to the same intricate incentive structure as the first-order interaction, a *PD* (see section 4 below).

Historical evidence of the *Turfan* records indeed shows that, in any community on the Silk Road, particularly *non-resident* Sogdian merchants regularly made use of the social-leverage mechanism. As mentioned, when Sogdian merchant *Kangwu Poyan* wanted to swap a camel with unit leader *Du* [], who was as a travelling merchant, he asked local merchants, the Sogdian *Kang* and the Chinese *Du*, to serve as guarantors, in an effort to overcome dominant incentives to defect in such a *one-shot PD among strangers*. And some contracts show that even conversely non-resident Sogdian merchants leveraged local trade as guarantors

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or witnesses. For instance, local merchants *Shi Randian* and *Kang* concluded a barter contract, where two non-resident Sogdians, *Luo* and *An* (last names were ruined), acted as guarantors (Hansen, 2010: 299; Jiang, 1994).

Greif *et al*. (1994: 751) argued for the case of Mediterranean trade that, when a large volume of trade was turned over among foreign merchants, 'a bilateral reputation mechanism cannot resolve the commitment problem'. In our case, the particular social-leverage mechanism of *multi-lateral* contracting generated a *multiplication of the reputation* effect and, thus, of the *credible threats* of punishment, as guarantors and witnesses involved were parts of some 'networked' commercial relations.

4. A game-theoretical reconstruction: the institutionalization of cooperation under 'social leverage'

For a more formal analysis of conditions of overcoming the trust, commitment, and cooperation problem, we consider three interconnected aspects of the social-leverage mechanism involved: (1) a *change of future expectations* through repeated secondary interactions; (2) a *second-order threat of punishment* for a defecting contractor and a related *change of the payoff structure*; (3) a superiority of cooperation in a *population* in an *evolutionary game-theory* perspective.

In the following, we assume just one guarantor/witness, *A*, having commercial relations with two core contractors, *B* and *C*.

Social leverage through the 'shadow of the future'

For the solution of a repeated PD, the well-known 'shadow of the future' in a 'single-shot' (Axelrod, 2006) has been widely applied. This refers to evolutionary process and evolutionary game theory. It reflects conditions under which agents have a sufficiently high expectation that interactions (with the same, or, in a wider sense, with a 'knowing' third agent in a population) will continue (Elsner and Heinrich, 2009). (The other one is more obvious: changing only the payoff structure, and perhaps even the game type, i.e., 'changing the preferences of agents', James, 2002: 292).

In the present case, *B* and *C* have a 'shadow of the future' determined also by the 'leverage' merchant *A*, and the probability of meeting each other is contingent on the probability of either of them (or both) meeting *A* in the future. Suppose that *through A*, β_{BC} $(0 < \beta_{BC} \leq 1)$ indicates *B*'s expectation to meet *C* and β_{CB} $(0 < \beta_{CB} \leq 1)$ v.v.

The minimally responsive strategy required, tit-for-tat (*TFT*; critical on the usual *TFT*-based solutions in trade: Barbara, 2016), and *ALL-D* are considered (in evolutionary game theory) to be applied by the agents in many random-paired interactions, with the common discount factor δ. We apply the usual solution to our *social-leverage setting*.

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For B, this exemplarily develops into the following current capital values of future payoffs of the two alternative strategy combinations (that stem from the well-known invadability criteria of evolutionary game theory):

$$\pi_{TFT/TFT} = R + \delta R\beta_{BC} + \delta^2 R\beta_{BC} + \cdots = \frac{R\beta_{BC}}{1-\delta} + R - R\beta_{BC}$$

and

$$\pi_{ALL-D/TFT} = T + \delta P\beta_{BC} + \delta^2 P\beta_{BC} + \cdots = \frac{P\beta_{BC}}{1-\delta} + T - P\beta_{BC}.$$

When $\pi_{TFT/TFT} > \pi_{ALL-D/TFT}$, B will cooperate. This condition holds, when

$$\delta > (T-R)/[T-R+(R-P)\beta_{BC}].$$

For C, we may use the same algorithm to obtain her condition.

This indicates that the social-leverage mechanism can enhance cooperation between two strangers, dependent on the probability of meeting the leverage merchant. The higher this probability, the easier the institution of cooperation will be socially learned in an evolutionary process in a population of primary traders.

Threat of second-order punishment in repeated 'social-leverage' interaction

A's businesses with B and C are considered *repeated* interactions, while B interacts with C strictly in a *one-shot* contract relation. The possibility (and expectation) of cross-contract punishment (or reward) from a (presumably) *repeated* social-leverage interaction (of B and C with A) then may create additional incentives to overcome the commitment problem.

If B or C defects, although they could obtain higher defection payoffs in the one-shot, a *negative payoff component* from the potentially repeated interaction with A will *change their overall incentive structure* (and the game type into a less intricate *coordination game*, or even a completely obvious *social-optimum game*, see below). We assume a PD to exist in both relations, between B and C, and A and B or C. B's and C's payoffs π from cooperative interaction with A then are as follows:

$$\pi_{B-A} = R + \delta R + \delta^2 R + \cdots = \tfrac{R}{1-\delta} \text{ and}$$
$$\pi_{C-A} = R + \delta R + \delta^2 R + \cdots = \tfrac{R}{1-\delta} \ .$$

The parameter δ $(0 \leq \delta < 1)$ is a common *discount factor* to calculate the present value of future payoffs. Also, as is well-known, when it is larger, the relationship is closer, or the probability in an interaction that the interaction (with the same, or a similarly well-informed third one) will continue is higher.

The payoff structure for the core contractors, when the contract involves guarantor A, results as follows (see Figure 2):

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Figure 2. PD with social-leverage (second-order) punishment.

R, R	$S, T-\frac{R}{1-\delta}$
$T-\frac{R}{1-\delta}, S$	$P-\frac{R}{1-\delta}, P-\frac{R}{1-\delta}$

$(S < P < R < T)$

Obviously, the payoff relation $R \gg P - R/(1-\delta)$ shows that the mutual advantage from choosing the cooperation strategy further increases over mutual defection. Also, in order for cooperation to become the dominant strategy for the contractors, the payoff relationships

$$R > T - R(1-\delta) \text{ and} \tag{1}$$

$$S > P - \frac{R}{1-\delta} \tag{2}$$

must hold. These imply

$$\delta > 1 - \frac{R}{T-R} = \delta_1 \text{ and} \tag{1a}$$

$$\delta > 1 - \frac{R}{P-S} = \delta_2 . \tag{2a}$$

A *social-optimum game* would result in that first-best result and cooperation were always the first-best choice for the contractors. Put differently, if any δ in any specific contract situation would be $\delta \geq \max\{\delta_1, \delta_2\}$, mutual cooperation would always appear. If only condition (1) or (1a) would hold (and (2) or (2a) would not), the dilemma would be transformed into a *coordination game*, where the cooperative solution might at least be easier achieved than in the dilemma.

It can also be seen that δ_1 increases with the decline of the incentive of unilateral defection, T, while δ_2 increases with the growth of the payoff from unilateral cooperation, S. Thus, for instance, when the defection incentive increases, or the unilateral-cooperation payoff decreases, the two long-term relationships in the social-leverage mechanism must become closer in order to make cooperation emerge with sufficiently high probability.

Conditions for superiority of cooperation in a population (or evolutionary game-theory) perspective

If Figure 2 were a *coordination game* with two Pareto-different Nash equilibria, the following relation would hold

$$R > T - R/(1-\delta) > P - R/(1-\delta) > S,$$

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due to the punishment from the social leverage. This may be considered (a variant of) a stag-hunt game with two equilibria, one *risk-dominant* (common cooperation), one *payoff-dominant* (defection, defection). This usually raises the problem of equilibrium selection. Here, we apply the standard solution of how the core contractors under social-leverage contracting may get sufficient trust to choose the risk-dominant equilibrium.

Assume that the column contractor chooses cooperation with probability p and defection with $(1–p)$, while the row contractor is cooperative with probability q and defects with probability $(1–q)$. Accordingly, for the row merchant, *expected payoffs* of strategies are as follows:

$$\text{For cooperation: } Rp + S(1-p).$$

$$\text{For defection: } [T - R/(1-\delta)]p + [P - R/(1-\delta)](1-p).$$

Thus, in order for the row player to cooperate, i.e., $\pi(\text{coop.}) > \pi(\text{defect})$, the column player must be expected to cooperate with probability

$$p > (P - S - R/(1-\delta)/(R + S + P - T).$$

Similarly, the column player will cooperate, when

$$q > (P - S - R/(1-\delta)/(R + S + P - T).$$

Under these conditions, the Nash equilibrium emerging (in an assumed underlying evolutionary replication mechanism in a population with these two types of strategies) will be {cooperation, cooperation}.

This shows, among others, that a larger expected *duration of the relationship* (or probability of future interaction) of the primary contractors with the leverage merchant(s), δ, will make the right side of the equation smaller so that the required probabilities p and q are easier met, c.p., i.e., the inequalities hold easier.

For the Silk Road cases, thus, two primary merchants with *a priori* low expectations to meet a cooperator may nevertheless achieve cooperation through the social-leverage mechanism, and the easier so the closer their relationships with the leverage guarantors or witnesses are.

The existence of courts as enforcement for private contracts

As explained above, the *Turfan* documents provide evidence of the existence and activity of courts as enforcement against criminal acts that might have transpired from private contracts. Find an illustration in *Figure 3* below. Let W the cost of both merchants, if they go to the court, M a sanction inflicted by the court to merchants, who did the criminal act (defection), and N a possible compensation from the guarantors (A or other relational merchants) in the court. When

$$R > (T - M) \quad \geq P \quad > \quad (S - W + N),$$

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Figure 3. Barter exchange (PD) with court activity.

R, R	$S - W + N, T - M$
$T - M, S - W + N$	P, P

$$(S < P < R < T, 0 < M, W, N)$$

as M and N change, the PD may transform into a *Stag-Hunt* game. When

$$R > (T - M), P > (S - W + N),$$

the PD is altered into a simple *coordination game*. As is well known, in both game types, two equilibria exist: One is risk-dominant {cooperation, cooperation}, one payoff-dominant {defection, defection}. This raises the problem of equilibrium selection.

We particularly consider a Stag-Hunt transformation through court activity to solve the original PD in a one-shot. Assume that the column merchant B with probability p chooses cooperation and with $(1 - p)$ selects defection. The row merchant C with q is a cooperative person, and $(1 - q)$ is a defector. Accordingly, for B,

$$\pi_{\text{cooperation}} = Rp + (S - W + N)(1 - p),$$

$$\pi_{\text{defection}} = (T - M)p + P(1 - p).$$

If $\pi_{\text{cooperation}} > \pi_{\text{defection}}$, namely,

$$p > (W + P - S - N) / (R + M + W + P - S - N - T),$$

B will choose cooperation. Similarly, when

$$q > (W + P - S - N) / (R + M + W + P - S - N - T),$$

C will choose cooperation. In all, when both conditions are met, the Nash equilibrium will be {cooperation, cooperation}.

Second-order dilemmas of costly punishment for guarantors and witnesses

When we derive conditions for a workable social leverage from social-dilemma formalism, the same formalism applies to the *second-order dilemmas* that *guarantors and witnesses* are involved in, and to their costly punishment. As is well-known in the economic literature of institutional emergence, *explicit punishment* on top of the endogenous punishment in repeated PDs of the

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first order (exerted through trigger strategies, such as *TFT*) creates a second-order dilemma. In our case, explicit punishment is '*outsourced*' *to the third parties of the* '*social-leverage*' *contract*, guarantors and witnesses. But formally, their PDs follow the same algorithms as for the first-order PDs of the primary contractors. And as they have expectations of repeated interactions with the primary contractors (and perhaps among each other) on their part, the same formal analysis would apply.

A full-fledged demonstration of institutional emergence in a population under social leverage, though, would require appropriate multi-agent-based modeling with games on network structures and simulations. But this is far beyond the present paper.

Why did a successful trade culture disappear?

Having established a considerably effective culture of social-leverage trading, why did the Sogdians dominance in the early central Asian Silk Road end relatively suddenly? The fate of Sogdian merchants after the 9th century, in fact, is unknown. But apparently, they did not vanish endogenously, e.g., because of some decreasing success. Rather, documents indicate an exogenous factor of collapse of their trade system. They show that many Sogdians supported the *An Lushan rebellion* against the Tang dynasty and suddenly had to escape from China back to central Asia. But nothing is left since that time (Rose, 2010: 418).

But considering *transaction costs* again, knowing that they always were considerable, although perhaps only tacitly, under the conditions of very high uncertainty in the case investigated here, they may have eventually affected the *relative efficacy of the land-borne trade versus alternative technologies coming up*. Specifically, the land-borne Silk Road had to change, and perhaps lost relevance, when big (Chinese) sailing ships emerged, with lower costs than those of camel caravans, facilitating a *maritime Silk Road* after another 100 years. We may only speculate that the *Lushan rebellion* of the Sogdians, in fact, was their last fight against a new techno-organizational system, the new Chinese super vessels, which brought them as far as to the African and Arabian shores.

5. Conclusions

This paper investigated into how the alien merchants overcame the particularly considerable trust, commitment, and cooperation problem in their inter-cultural long-distance trade in the most remote central Asian areas of the early medieval Silk Road. We showed how a particular mechanism of 'relational' contracting, a 'social leverage', was developed. These contracts became somehow self-enforcing.

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To formally analyze the historical records, a game-theoretical model of social leverage was developed. We concluded that a social-leverage mechanism can indeed explain conditions for large-scale trade on the Silk Road.

Generalizations of social-leverage contracting from our cases and formal analysis may apply to all current and future new economic developments, where a proper legal frame has not been developed (yet). This has been generalized in economics to all kinds of *experience* or *credence goods*, which entailed 'market failures' such as *adverse selection* and *moral hazards* in earlier times when there still was little legal customer protection.

Examples from the 1990s and 2000s were the early problems of *valuation of software* and similar intangibles and services of software firms in the dot.com industry for *accounting and taxation*, when there were no clear accounting rules set up yet for the new industry. Furthermore, since the 1990s, when *e-commerce* exploded, the particularly extensive uncertainties of the early *internet trade* could, in the absence of sufficient internet law and adapted business law, be remedied only through *private reputation mechanisms* and rankings, as established and supported by big hierarchies, such as *eBay* or *Amazon*, through chat groups or product tests made public, or by other remedies like online payments protected by PayPal and the likes.

Nowadays, under increasing 'balkanization' of the internet, breaking down the internet into well-arranged and manageable *smaller networks*, how staged and interlinked ever, similar private reputation and social-leverage mechanisms with *witnesses*, *guarantors*, or relational advocates are established, be it for applying debtors in *crowd funding*, or for future internet banking of the upcoming *FinTechs*.

Such techno-economic developments will usually have a temporal lead over legal regulations, which typically will lag behind. In such legally undefined domains and phases, often more or less transitional, tacit social dilemmas are ubiquitous, and private social-leverage mechanisms of learned and institutionalized cooperation will always have a role to play, in order to let techno-economic developments proceed, or even make them take off at all (how insufficient those private solutions ever may be).

Finally, and more generally, not only when formal-legal solutions cannot catch up, or have not caught up yet on technical-organizational private developments, private social-leverage solutions may play a permanent role in substitution of formal-legal ones – and then may even be supported proactively by public policy to come into a strong existence. Public policy then has a whole range of critical factors to shape (as should have become clear from the above) in order to support such private social solutions and to make public ones perhaps completely redundant (except for such a framework regulation as mentioned).

Thus, there would be a lot to learn from the Silk Road.

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