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## Trust and Social Control. Sources of cooperation, performance, and stability in informal value transfer systems

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# **Trust and Social Control**

*Sources of cooperation, performance, and  
stability in informal value transfer systems*

**Claudius Gräbner, Wolfram Elsner  
and Alex Lascaux**

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(First revision)

# Trust and Social Control.

## Sources of cooperation, performance, and stability in informal value transfer systems

Claudius Gräbner,<sup>1</sup> Wolfram Elsner,<sup>2</sup> and Alex Lascaux<sup>3</sup>

*This version: November 27, 2017*

### Abstract (170 words)

We study the functioning of informal value transfer systems (IVTS) through the example of Hawala. More precisely, using computational experiments we examine the roles of generalized trust and social control for the emergence, stability and efficiency of Hawala. Previous literature was ambiguous with regard to: (i) how trust and control should be operationalized formally, (ii) which, if any of the two, carries a larger relevance for the functioning of IVTS, (iii) whether (and when) they relate to each other as substitutes or complements, and (iv) how they interact with other conditions. Our experiments submit answers to all these questions. They show that both trust and control are necessary, but not sufficient to guarantee the functioning of Hawala, and that their relationship is time-dependent. The success of Hawala also depends on context factors such as population size, interaction density, and forgiveness of the agents. Aside from clarifying those questions, we provide a theoretically grounded operationalization of generalized trust and social control that is applicable to informal exchange systems in general.

### JEL Codes

C63; C7; D02; D83; G29; O17.

### Keywords

Computational Experiments; Game Theory; Hawala; Institutions; Social Control; Trust

### Highlights

- We propose a formal operationalization of general trust and social control.
- We provide a computational platform to study trust and control in informal value transfer systems.
- Trust and social control are both necessary but not sufficient to ensure the functioning of Hawala.
- The complementarity/substitutability relation of trust and control changes over time.
- We identify sufficient framework conditions required for the system to work efficiently.

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## 1. Introduction

Many financial transactions in emerging economies are arranged on an informal institutional basis. This means that they cannot be monitored or enforced by the formal authorities and their official regulation is possible only to a limited extent. Examples of these informal financial activities include Rotating Savings and Credit Associations, interlinking agricultural loans, informal value transfer systems (IVTS), and other ‘nonmarket institutions’ (Besley, 1995), which are governed by the informal rules that are learned, internalized, and reinforced by the group members.<sup>4</sup> But until now, ‘very little is known about the mechanisms used by these groups to ensure that members abide by their obligations’ (Anderson et al., 2009). Here we seek to explore the governance mechanisms accounting for the emergence, stability and enduring success of one of the most significant informal financial institutions, which is involved in unofficial money transfer around the world and called *Hawala*.

People use Hawala to transfer cash from one country to another (see figure 1): a sender of money approaches an intermediary called *hawaladar* and hands him a sum of money. The hawaladar contacts another hawaladar in the target area and informs him about the amount of money to be transferred and a remittance code. The final receiver of money then contacts the second hawaladar, reproduces the remittance code and receives the money (we explain the functioning of hawala in more detail in section 2). Such a transaction lasts only several hours (or days in case of very remote territories) and hawaladars charge only small commission fees ranging from 2 to 5 percent of the amount transferred. After completing a transfer all traces of the transaction are removed. Estimates of the amount of money transferred through Hawala range from 100 billion dollars (Razavy, 2005; Schneider, 2010; Schramm and Taube, 2003) to as much as 680 billion dollars per annum (Shehu, 2004). It is, therefore, considered one of the most important IVTS worldwide (Rusten Wang, 2011).

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<sup>4</sup> With institutions we refer to systems of rules, beliefs, and norms, which “provide individuals with the cognitive, coordinative, normative, and informational micro-foundations of behavior as they enable, guide, and motivate them to follow specific behaviour” (Greif, 2006, p. 42).

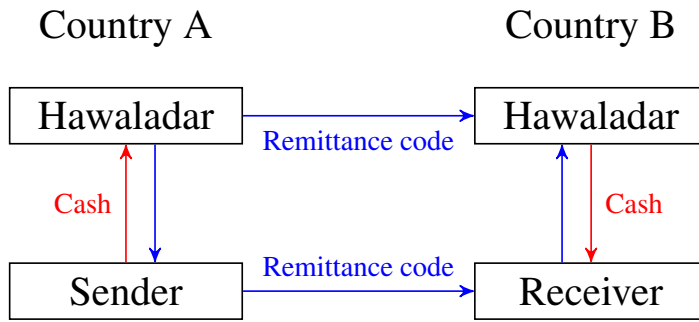


Figure 1: *Illustration of the operation of Hawala.*

Given the informality and legal unenforceability of financial claims among Hawala participants, the obscurity and impenetrability of the system's workings, and abundant opportunities for swindling clients and partner hawaladars out of their money, an important question arises: How does Hawala stabilize the expectations and coordinates the behavior of its participants so as to deter opportunistic defection? The existing literature discusses two major stabilizing mechanisms preventing intermediaries' opportunistic behavior: trust and social control (Bijlsma-Frankema and Costa, 2005; Costa and Bijlsma-Frankema, 2007; Das and Teng, 2001; 1998; Piccoli and Ives, 2003; Sasaki and Uchida, 2013).

Until now, however, no commonly accepted definition or formal operationalization of trust or social control exists in the context of informal financial transactions. It is therefore not surprising that there is considerable debate about the precise functioning of trust and control, their interrelation, whether they are substitutes or complements, and whether their relative importance varies over the lifetime of an IVTS. Here we propose a theoretical framework and a formal model to clarify these questions. We also conduct computational experiments in which we directly represent the functioning of Hawala, and in which trust and social control can be rigorously defined and distinguished. This way we will not only be able to show that both trust and social control are *necessary* for the successful operation of Hawala and that their relation follows a particular *temporal structure*, but we will also be able to demonstrate that taken in isolation, both are *not sufficient* for the success of Hawala. Furthermore, our framework allows us to identify other conditions, which, together with trust and social control, are sufficient for an efficient operation of the system. These results complement and extend existing game-theoretical treatments of the subject. Because our operationalization of trust and social control is generic, our results generalize beyond the example of Hawala.

The remainder of this paper is structured as follows: Section 2 describes the key features of Hawala and its functioning. Section 3 elaborates on trust and social control as potential factors of emergence and stabilization of IVTS and informal exchange systems more general. Section 4 presents our operationalization and the formal model. Section 5 summarizes the results of our computational experiments, with a broadening discussion ensuing in section 6. Section 7 concludes the paper. We discuss the dynamics of our model and a more extensive sensitivity analysis in the supplementary material. The program code is openly accessible and well documented on GitHub.

## **2. The functioning of Hawala as an informal value transfer system**

Hawala is a venerable, century-old international system of long-range value transfer, with its origins traced to ancient China and the Middle East (Qorchi, 2002; Rusten Wang, 2011). It continues to operate in a large number of territories and proves its resilience in competition with powerful rivals, such as globally operating formal banks, wire transfer companies, and mobile payment services. It is widely used by migrant worker communities that have settled in Europe, North America, and the Gulf region and send remittances to their families in South Asia, Africa, Latin America, and elsewhere (Qorchi, 2002; Rusten Wang, 2011). Although it is often associated with the Muslim culture, there is nothing in this practice which can be specifically related to the Islamic tradition (Parandeh, 2009; Razavy, 2005). It is open to any customer, regardless of her religious or cultural affiliation, who needs to send or receive money across the borders and wants to get this service done rapidly, inexpensively, and reliably.<sup>5</sup>

Therefore, Hawala maintains a prominent place among IVTS, despite being prohibited in a number of countries (India, Iran, Pakistan) and heavily regulated in others (the UK, the Netherlands, the United Arab Emirates). The fact that Hawala often has to operate in the ‘shadow’ of the law underpins that its functioning is highly dependent on a broad social acceptance of and adherence to its informal rules.

Strictly speaking, Hawala does not engage in transferring money between various geographic locations, either physically or electronically. Instead, it arranges a series of swap operations. Any pair of hawaladars has to periodically cancel out their mutual financial obligations. If imbalances persist, outstanding debts between hawaladars can be settled through cash delivery, side payments via conventional banking channels, or even trade arrangements with artificially inflated

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<sup>5</sup> For a more detailed discussion of the competitiveness of Hawala, we refer to the supplementary material.

or depressed prices for imported and exported goods and services (Lambert, 2002; Razavy, 2005; van de Bunt, 2008). Balancing the books in the latter way is facilitated by the fact that ‘most hawala transactions are conducted in the context of import and export businesses’ (Shanmugam, 2005). Typical business ventures involved include ethnic stores, grocery shops, travel agencies, and money-changing services (Parandeh, 2009; Rusten Wang, 2011).

Given the informality and legal unenforceability of financial claims among Hawala participants, the obscurity and impenetrability of the system, and multiple opportunities of swindling clients and partner hawaladars out of their money, the question arises: How does Hawala survive and thrive, particularly in an environment of growing competition with well-established formal rival systems? Hawala participants cannot go to police, courts etc. with allegations of others’ fraudulent behaviors, as their claims would be extremely difficult to verify. Thus, it is obvious that between each two hawaladars there exist opportunities, and in fact *incentives*, to cheat and exploit the other side, which would give the unilateral defector, the maximum possible gain within the transaction, and leave the exploited unilateral cooperator with a loss. Assuming that common defection will put them on a par (at the second-lowest payoff), as would common cooperation (with the second-highest payoff possible), this IVTS essentially exhibits the characteristics of a *social dilemma*. The theoretical prediction, therefore, would be that the system gets stuck in the logic of repeated one-shot Nash equilibria, with a relatively inferior performance, and little evolutionary stability among its competing subsystems.

However, in reality Hawala demonstrates a considerable endurance and significant competitive advantages over its rivals. So how specifically does Hawala generate and stabilize expectations of trustworthiness and cooperation, and coordinate the behavior of its participants so as to deter opportunistic defection? How exactly does it generate and stabilize informally institutionalized cooperation? Building upon the literature, we envisage two major cooperation-generating, stabilizing, and performance-enhancing mechanisms: emergent *general trust* and systems of *social control*. We will investigate their relative relevance for system performance, including their temporal relationship and crosscheck the two mechanisms against a number of framework conditions. In doing so, we will focus on the interaction arena of, and relationship among, the hawaladars, thus leaving the examination of client-hawaladar relationships for further research.

### **3. Trust and social control as institutional drivers of informal exchange systems**

Many researchers posit that informal exchange systems, including Hawala, are premised on *trust* (Lambert, 2002; Parandeh, 2009; Shanmugam, 2005; van de Bunt, 2008). Trust is believed to alleviate the concerns over the delivery of cash, bolster the confidence in the working of the system even in the absence of verifiable records, and allow for long-standing imbalances in the flows of transactions without any request for reclamation and immediate settlement (Lambert, 2002; van de Bunt, 2008).

Also *social control* mechanisms have been conceptualized in different forms in the literature, suggesting their pivotal role in stabilizing cooperation in informal exchange systems. The instruments of social control that exert pressure on Hawala participants are supposed to be based on the commonality of their cultural precepts, dense interconnectedness, and the expectations of continuing interactions in the future (Razavy, 2005; Schramm and Taube, 2003). Finally, the need to protect reputation of integrity is also considered a powerful element of social control (Ballard, 2005; Nakhasi, 2007).

However, there is no consensus in the literature on IVTS as to what extent trust is relevant compared to social control, or whether they act as substitutes or complements. In the following, we will take an evolutionary game-theoretic perspective to develop a theoretical framework and a formal model to rigorously operationalize trust and social control and to clarify their respective roles in informal exchange systems in a computational experiment.

We will conceptualize *generalized trust* as the willingness of an agent to cooperate even if she has no information about her counterpart (a ‘stranger’) and knows that it may be a one-shot interaction only, in which the partner has the option (and an incentive) to exploit her. Trust thus implies ‘the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party’ (Mayer et al., 1995). Such a conception of trust aligns with the approach of the *World Value Survey* (WVS, 2015) where ‘general trust’ is measured via questions such as “Do you think you can trust the next person you may incidentally meet?”. Manapat *et al.* (2013) use trust similarly in a trust game, in which the degree of trust of an investor is measured by the probability of transferring money to a trustee she does not know, a ‘leap’ of faith (and money) to a stranger as in our definition. Generalized trust is considered to have become learned, habituated and institutionalized across a critical number of interaction arenas, and thus become independent of a particular interaction context and applied in one-shot interactions even with strangers (Elsner and Schwardt, 2013).



*Social control*, in contrast, is understood as an ability to influence other agents' behavior through the use of sanctions (Das and Teng, 1998). It is well known in the game-theoretic literature that the implementation of effective sanctioning mechanisms is often difficult and not practical, in particular because sanctioning is often costly (a second-order dilemma). A form of sanctioning in the case of Hawala, which does not incur significant costs to the sanctioning player, is the exclusion of fraudulent players from further interactions. Such a form of sanctioning is particularly effective if the exclusion is not only effected by the exploited agents, but turns into a social sanctioning mechanism applied by several agents (Joshi and Mahmud, 2018). Such a mechanism requires some memory, monitoring, or communication on reputations. A similar operationalization is given, for example, by Sasaki and Uchida (2013) in a game-theoretic model in which they provide stability results for equilibria in which fraudulent players get successfully excluded from a cooperative population. In Hawala, for instance, defectors may be expelled from the hawaladar community. The threat of ostracism should diminish the potential of opportunistic behavior.

These conceptualizations beg the question of whether the trust-control relationship in informal exchange systems is characterized by complementarity or substitution (Bijlsma-Frankema and Costa, 2005; Costa and Bijlsma-Frankema, 2007). The *complementarity* perspective (Bachmann, 2001; Das and Teng, 2001; 1998) implies that trust and social control can mutually reinforce each other, jointly building high expectations in partner cooperation. Agents are supposed to simultaneously rely on somehow socially grounded trusting attitudes and on the reputational and sanctioning mechanisms when forming their expectations. In contrast, the *substitution* perspective (Alvarez et al., 2004; Huemer et al., 2009; Piccoli and Ives, 2003) suggests that a higher level of trust comes with a decrease of control, and vice versa. This may even include the possibility of a *mutual crowding-out*, when, for instance, social control with its threat of ostracism makes trust redundant (Lascaux, 2015), or, on the other hand, increasing general trust would make control superfluous. The different hypotheses are summarized in Table 1.

To investigate the actual working of the two mechanisms, their interrelation and *relative impacts*, and the potential *time structure* of these impacts, we develop a formal model and run a number of computational experiments with artificial agents interacting under different conditions.

Hypothesis	References
<i>The relative importance of trust and social control</i>	
The emergence, functioning and efficiency of Hawala is based mainly on generalized trust.	Lambert (2002), Shanmugam (2005), van de Bund (2008), Parandeh (2009)
The emergence, functioning and efficiency of Hawala is mainly due to social control.	Ballard (2005), Nakhasi (2007)
<i>The relationship between trust and social control</i>	
Trust and social control are complements, i.e. they reinforce each other.	Bachmann (2001), Das and Teng (2001; 1998)
Trust and social control are substitutes, i.e. more trust comes with a decrease of control, and vice versa.	Alvarez <i>et al.</i> (Alvarez et al., 2004), Huemer <i>et al.</i> (2009), Piccoli and Ives (2003)
The relationship between trust and social control changes over time, with trust being crowded out by social control over time.	Lascaux (2015)

Table 1: *Hypotheses about the sources of emergence, stability and efficiency in Hawala, as found in the literature.*

## 4. The Model

The model reflects the functioning of Hawala and of ITVS more general and provides a rigorous operationalization of generalized trust and social control. This will allow us to test the aforementioned hypotheses on the respective roles of trust and control, and to derive more refined results on their temporal structure and other important factors.

### 4.1. Model setup and parameters

The parameters of the model are summarized in table 2. We consider a population of  $N$  agents (hawaladars) that are allocated equally to  $M$  regions. There are two main types of agents:

1. *Cooperative agents* will *always* cooperate if they decided to enter an interaction.
2. *Selfish agents* are willing, under certain conditions, to exploit their fellows.

Both types of agents have two behavioral traits: relying on *general trust* and/or *social control*. The level of trust and control is specified by the variables  $\tau$  and  $\kappa$  respectively.

For *cooperative agents*,  $\tau \in \{0,1\}$  (they may have trust or not) and  $\kappa \in \{0,1\}$  (they may employ social control or not). *Selfish agents* always have  $\tau = \kappa = 1$ , as they (logically) always ‘trust’ (hope) that the other one will cooperate in order to exploit her, and as they apply social control since they expect

others to potentially cheat on them as well.<sup>6</sup> The precise functioning of trust and control and our formal operationalizations will be explained below (section 4.2).

Parameter symbol	Parameter description	Value/ Value Range
<i>Main independent variables</i>		
$\tau$	Trust of cooperators	0 or 1
$\kappa$	Use of control by cooperators	0 or 1
<i>Control variables</i>		
$N$	Number of hawaladars	50 - 1000
$M$	Number of regions	25
$T$	Number of time steps	500 - 750
$I_{max}$	Maximal number of interactions per time step	10 – 500
$\gamma_0$	Initial share of cooperative hawaladars	50% - 75%
$\rho$	Resentment period: The number of interactions a cheater will get rejected by those who were informed about her behavior, an inverse of <i>forgiveness</i> (cf. (Axelrod, 1984)) or <i>tolerance</i> .	1 – 100
$\lambda$	Replication indicator: Percentage of hawaladars who update their strategy.	10 - 20%

Table 2: Overview of the parameters of the model. While our initial main interest lies in the effect of trust and social control, we later investigate the effect of the other variables as well.

## 4.2. Sequence of events

Every simulation run consists of a fixed number of *time steps*., as illustrated in figure 2: First, a number of *interactions* take place, the maximum number being specified by the parameter  $I_{max}$ . Secondly, after all interactions of a time step are completed, agents update their strategies. At the end of each time step, the relevant statistics of the time step get recorded. We will now go through this sequence in more detail.

<sup>6</sup> At first sight, it may seem counter-intuitive to argue that selfish agents have trust and use social control, as both are mainly considered mechanisms to foster general cooperation. But trust as defined here captures the willingness to interact with strangers. Since selfish agents are willing to exploit others, they have an interest to interact with strangers, as these are easier to exploit. Considering social control, since selfish agents are willing to exploit others, they would expect others to do this as well and would therefore be more skeptical of the behavior of others, thus employing some control.

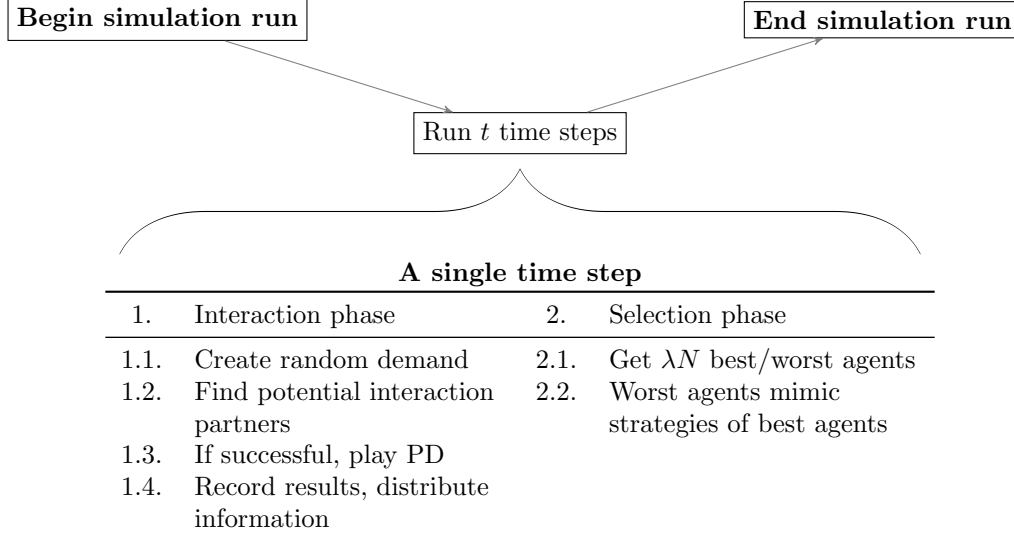


Figure 2: The course of a single simulation. Final results come from Monte Carlo simulations of many simulation runs.

#### Procedure of an interaction

The procedure for each individual interaction is summarized in table 3.

1	Create a random demand, i.e., a money amount to be transferred from one region to another.
2	Choose a random hawaladar in the first region.
3	Find an interaction partner in the second region.
4	The potential partner either accepts or rejects the interaction. If she rejects, the interaction does not take place.
5	If the potential partner accepts, agents play a PD as depicted in figure 4.
6	Record the results of the interaction for both agents.

Table 3: Sequence of events for a single interaction.

First, a demand for a money transfer service between two regions is created stochastically by choosing two different regions, denoted by  $\gamma$  and  $\varkappa$ , with uniform probabilities. Among the agents (hawaladars) located in the first region, one is chosen randomly. This agent will be denoted  $H_1$ . She now needs to find an interaction partner in the second region. Her decision procedure is illustrated in figure 3: She first checks whether she has a *business associate* in the second region (we explain below how agents form business relationships). If she has, she contacts the associate. If she has more than one, she contacts one at random. We denote the set of associates of  $H_i$  in region  $\varkappa$  as  $P_{i\varkappa}$ .

If  $P_{i\varkappa} = \emptyset$ , it depends on her *trust* whether she is willing to contact a stranger for her business: If  $\tau_1 = 1$ , she will contact a random agent in  $\varkappa$ ; if  $\tau_1 = 0$ , she will not engage in this interaction and

forgo the business opportunity. If  $\kappa_1 = 1$ , she will not contact any hawaladar that has cheated on her (or one of her business associates) previously.

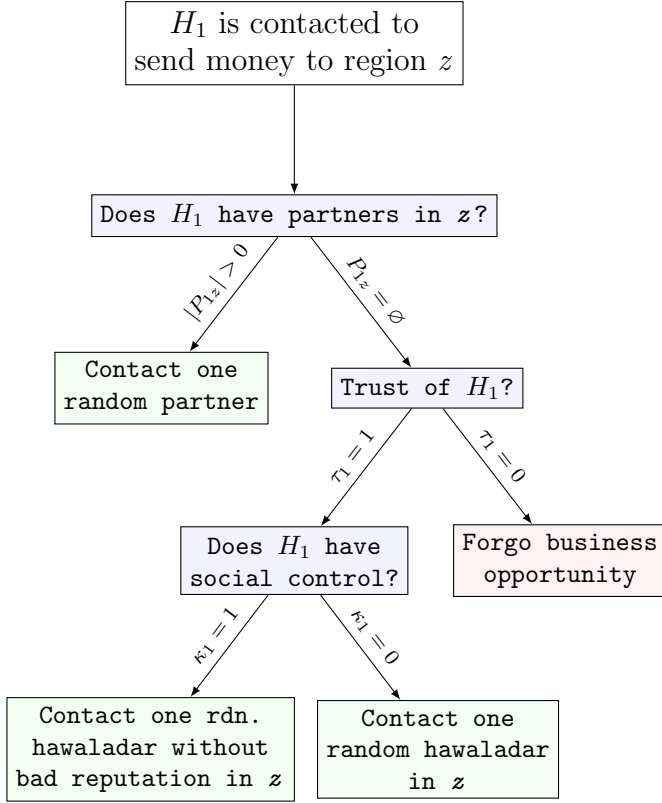


Figure 3: Decision tree for the first hawaladar (the sender).

When a hawaladar in  $z$ , denoted  $H_2$  is contacted, she can either accept or reject the interaction. The corresponding decision procedure of  $H_2$  is illustrated in figure 4: If  $H_2$  has already interacted with  $H_1$  before, and this interaction was positive ( $H_1$  did not cheat on  $H_2$  and  $H_1 \in P_{2y}$ ), she will accept the interaction. If the previous interaction was negative ( $H_1$  cheated on  $H_2$  and thus  $H_1 \notin P_{2y}$ ), and  $\kappa_2 = 1$ ,  $H_2$  rejects to interact with  $H_1$  for  $\rho$  periods.

If there has not been any interaction between the two hawaladars before and if  $\kappa_2 = 1$ ,  $H_2$  first checks whether she or one of her business associates was cheated by  $H_1$  in the previous  $\rho$  periods. If this was the case, she will reject the interaction. In case there is no information about the potential partner, i.e., it is a complete stranger, it depends on the *trust* of the potential partner: If  $\tau_2 = 1$ , she will give the interaction a try. If  $\tau_2 = 0$ , she will ‘play safe’ and reject the interaction.

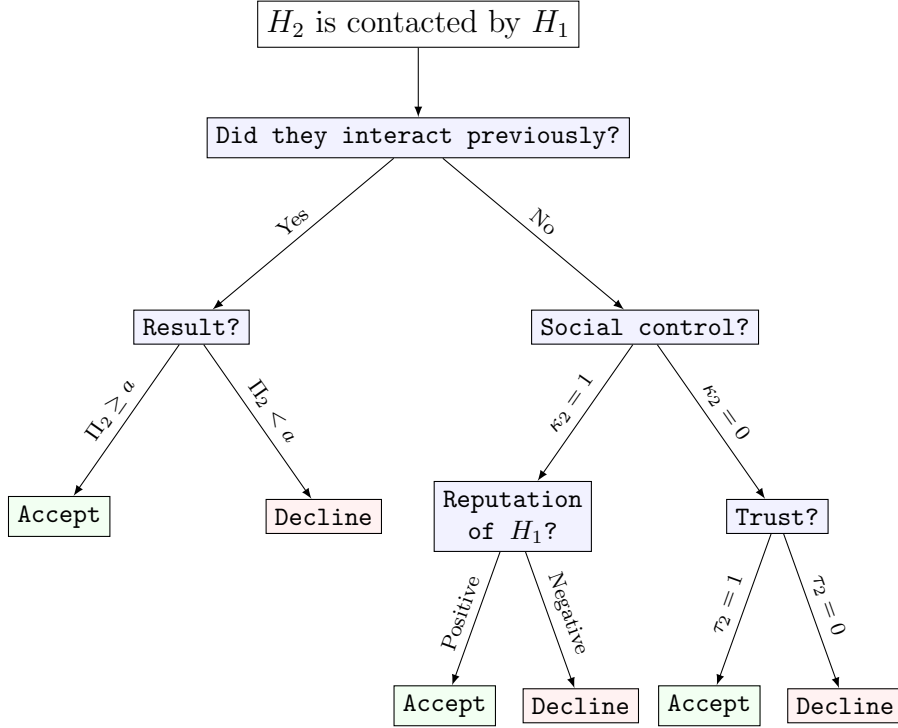


Figure 4: The decision tree for the second hawaladar (the receiver).

At this stage we re-state our operationalization of trust and social control, which we consider to be generic and applicable to any informal strategic interaction system that involves a population of heterogeneous agents:

*Our operational definition of general trust* defines it as the willingness to interact with someone one has no information about and who has the potential capability to harm one.

*Our operational definition of social control* defines it as the ability and willingness to memorize, monitor, communicate, and sanction defectors.

These precise operationalizations capture the essence of both trust and social control as discussed previously.

#### Game type and incentive structure

If two agents have agreed to interact, they play a *PD* with the payoff structure as depicted in figure 5. As discussed, we formalize the interaction as a *PD* because it is an ubiquitous incentive structure and decision problem for the agents in any informal exchange system (see section 2 above).

		Hawaladar 2	
		C	D
Hawaladar 1	C	$a$ $a$	$b$ $d$
	D	$d$ $b$	$c$ $c$

		Hawaladar 2	
		C	D
Hawaladar 1	C	4 4	8 -2
	D	-2 8	0 0

Figure 5: *The payoff structure for the underlying prisoners' dilemma.*

This particular payoff structure deserves explanation. We chose the values to resemble the real situation of hawaladars. The payoff of *mutual defection* should be zero, i.e., benefits and losses would be mutually balanced between two interacting agents.<sup>7</sup> So the only parameters we have for setting the *fierceness of the PD* are the remaining payoffs  $b$ ,  $a$ ,  $d$ . Later we study how severe the dilemma structure could be to still allow for cooperation in particular settings (see section 5.4 and the sensitivity analysis in the supplementary material).

#### *Information recording and distribution*

After an interaction, the agents are awarded their payoffs, will record the relevant information about the interaction, and adapt their settings and behaviors accordingly: If  $\Pi_i > 0$ , agent  $j$  becomes an associate of  $i$  and vv. Otherwise (if  $\Pi_i \leq 0$ ),  $i$  will remember  $j$  as a defector and will reject her the next  $\rho$  times (see section 5.3 on the degree of forgiveness). Furthermore, if  $\kappa_i > 0$ ,  $i$  also *informs all of her associates* about  $j$ 's defection. They all will then reject  $j$  (for  $\rho$  interactions) as if they had been exploited by her themselves.

#### *Replication: Selection procedure for strategies*

After all interactions have taken place, agents change their strategies according to conventional learning: If they perform particularly badly, i.e., belong to the  $\lambda N$  most unsuccessful agents in terms of accumulated payoff, they change their strategy. The probabilities for their new strategies to be chosen shall be equal to the distribution of strategies of the  $\lambda N$  most successful agents.

We tested for several criteria to determine the relative success of agents, for example, ranking them according to their *total accumulated payoff*, the *payoff in the previous time step*, or the *average payoff* across a number of time steps. Here we may anticipate results of the sensitivity analysis and state

<sup>7</sup> Even if  $c$  would be negative, the qualitative results of simulations of the model would not change. Only if  $c > 0$ , the dynamics would change; but it does not make sense to think of mutual defections being more favorable than no interaction at all.

that the effect of the particular measure chosen is marginal compared to other parameters and mechanisms driving the outcome. Also, there are no qualitative changes dependent on the particular value of  $\lambda$ . We thus chose  $\lambda = 15\%$  for most simulations.

## 5. Results

### 5.1. The respective impacts of trust and control

To clarify the respective roles of trust and social control and scrutinize the first pair of hypotheses in table 1 we compare four baseline constellations:

1. Cooperative agents have  $\tau = \kappa = 0$ , so neither do they have trust nor do they use social control.
2. Cooperative agents have  $\kappa = 0$ , but  $\tau = 1$ , so they have trust but do not use social control.
3. Cooperative agents have  $\kappa = 1$  but  $\tau = 0$ , so they use social control but do not have trust.
4. Cooperative agents have  $\tau = \kappa = 1$ , so they have trust and use social control.

In order to judge the effects on the functionality of the system, the following four state variables of the system are of particular interest:

- (i) share of successful interactions,
- (ii) type of interactions that have taken place (i.e., mutual defection, exploitation, or cooperation),
- (iii) final share of cooperators,
- (iv) efficiency of the system; efficiency is defined as the total realized payoff divided by the maximum payoff possible, i.e. the total wealth that would result if all potential interactions would have been carried out as mutual cooperation.

All results will be displayed by the mean and the 10/90-percentiles. The number of simulation runs was determined according to the ‘systematic design of experiments’ as described in Lorscheid et al. (2011). For the baseline analysis, we analyze 50 simulation runs, which do not show much inter-run variation.<sup>8</sup> Figure 6 and table 4 summarize the results after 750 time steps.

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<sup>8</sup> This becomes particularly evident if one looks at the dynamics of the model directly, see e.g. figure 5.3 below and the discussion of the dynamic in the supplementary material.



The dynamics of adjustment are illustrated in more detail in the *supplementary material*. After 750 time steps, the system clearly settled to equilibrium.<sup>9</sup>

The results indicate that *both trust and control are necessary* for the system to function properly:

- (1) *Without both trust and control* we observe a complete breakdown of the system: no interactions take place and almost no payoffs are realized. Consequently, the further selection of strategies is completely random since no agent accumulates payoffs and can be considered more successful than others. The final share of cooperators thus is almost completely random, as the upper and lower limits of 0 and 100% indicate.
- (2) A similar result occurs if cooperators use *social control, but do not have any trust*. In this case, the system does not take off either: Since no cooperator has trust, they do not form any relationship among cooperators, and only the selfish agents actually operate in the beginning. But using social control, the activity of the selfish agents gets suppressed quickly so that after a short period no interactions take place at all.
- (3) If cooperators have *trust but no control*, they interact naively also with known defectors, get exploited and extinct. The few realized interactions are mutual defections among selfish agents, and the system remains highly dysfunctional.
- (4) If, however, cooperators *use social control and have trust*, the system approaches a state of considerable efficiency: selfish agents are crowded out of the system, almost all interactions take place, and on average almost 80% of the potential payoff can be realized.

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<sup>9</sup> We speak of an equilibrium once we cannot observe any relevant further change in the variables of interest. This usually happens after 450 time steps. But to be sure, we also report the results after 750 time steps. See the dynamics as shown in the supplementary material.

	<i>Dependent variable:</i>			
	Real. transact.	Cooperations	Efficiency	Cooperators
	(1)	(2)	(3)	(4)
Trust	1.480*** (0.231)	0.000*** (0.000)	0.970** (0.414)	−65.260*** (5.876)
Control	0.000 (0.231)	0.000*** (0.000)	0.000 (0.414)	18.200*** (5.876)
Trust & control	96.660*** (0.326)	100.000*** (0.000)	73.696*** (0.585)	81.800*** (8.309)
Observations	200	200	200	200
R <sup>2</sup>	0.999	1.000	0.996	0.630
Adjusted R <sup>2</sup>	0.999	1.000	0.996	0.624
Residual Std. Error (df = 196)	1.153	0.000	2.068	29.378

Note:

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Table 4: The results for the baseline scenario, which refer to OLS regressions applied to the results of 50 simulation runs of each case and the state variables after 750 time steps.

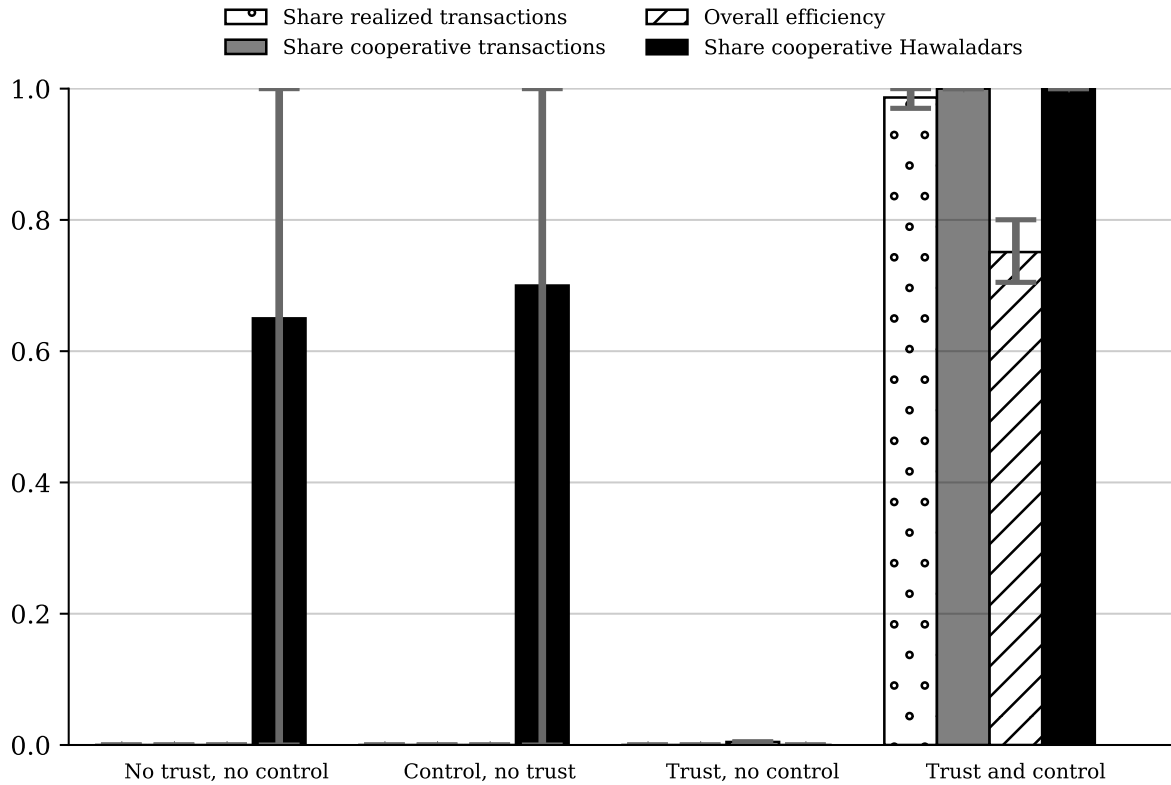


Figure 6: Results for the roles of trust and control – Illustration. The graph shows the means and 10<sup>th</sup> and 90<sup>th</sup> percentiles of 50 simulation runs after 750 time steps.

Against the insight that both trust and social control are necessary for systems such as Hawala to function we now turn to the temporal structure of trust and control.

## 5.2. The temporal structure of trust and control impacts

We test the second set of hypothesis outlined in table 1, which refer to the dynamic relationship of trust and control. Lascaux (2015), for instance, suggested that trust is only important in the beginning, but crowded out by social control over time. To test this, we ‘shock’ the system by exogenously setting the trust or control values for cooperators to zero after a particular number of time steps.

The results are illustrated in figure 7. The single bar on the left of every panel refers to the case where no shock affects the system. Bars indicating the results for a shock at time step zero are equivalent to runs where no trust or control operate at all. These cases serve as ideal benchmarks to facilitate the interpretation of the other outcomes.

The first observation confirms the importance of the timing of shocks: we see that shocks after 300 time steps have little or no effect since the system already settled into a stable equilibrium. However, earlier shocks that reach the system out of its equilibrium can have profound and self-reinforcing effects.

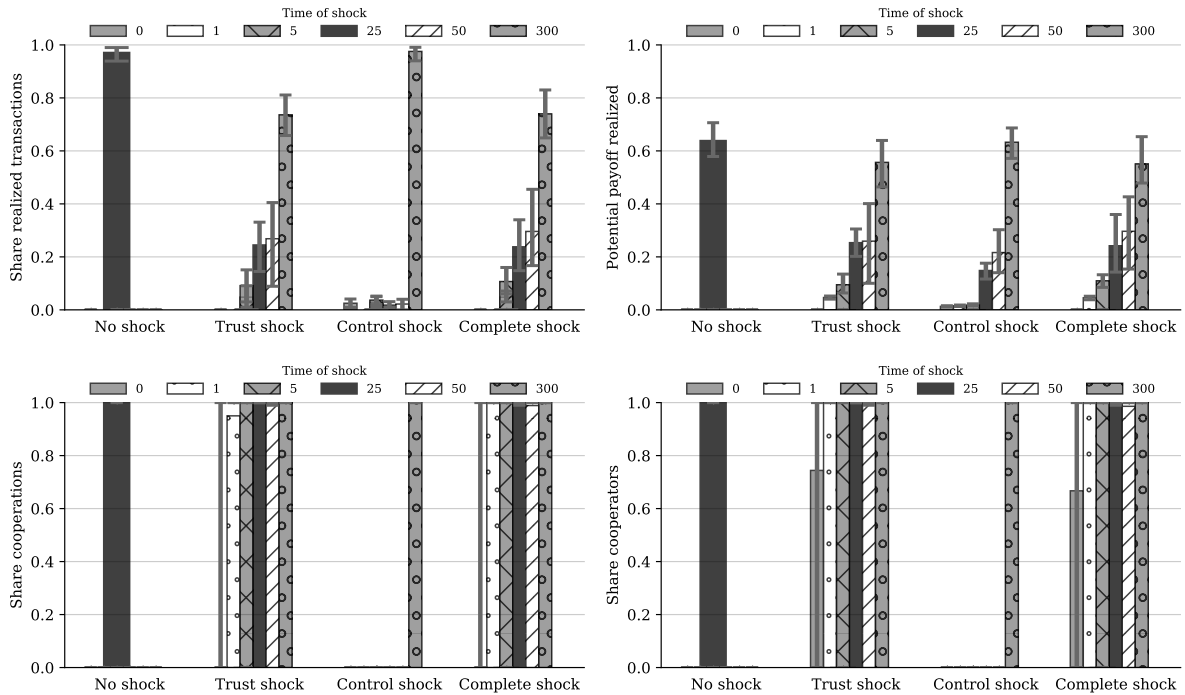


Figure 7: The effects of trust and control shocks at different time steps. The figure shows the means of 10 simulation runs. Whiskers again indicate the 10<sup>th</sup> and 90<sup>th</sup> percentiles.

At least for the trust and complete (trust plus control) shocks, it holds that the earlier the shock, the more profound and persistent its impacts. The reason why earlier trust shocks have more profound effects is straightforward: in the beginning, agents do not know each other. They can form new relationships only if they trust strangers. Once trust gets eradicated from the system, no additional relationships can be formed and successful transactions only pass through the (few) relationships already formed. Thus, even if after a trust and complete shock, all agents end up being cooperative (see lower right panel) and all realized interactions are cooperations (lower left panel), but the share of realized transactions gets significantly reduced (upper left panel) and the efficiency of the system goes down accordingly and reaches obviously unsustainable values (upper right panel). The fact that a trust shock after 300 time steps still reduces efficiency of the system, indicates that at this point not all agents have formed partnerships with each (see figure 7, upper panel, for the dynamics of this process). Consequently, it makes a difference for the system whether there is no trust at all – in which case the system breaks down – or trust gets eradicated after some time. In the latter case the system works inefficiently (and, presumably, not sustainably), but does not break down completely. These results align with the argument in (Lascaux, 2015), but the conclusion is somewhat more specific as we do not observe a complete crowding-out of trust. Thus, trust is, and remains, the alley of control, on which interactions become feasible and relation building is facilitated.

*Social control*, then, may stabilize, qualify, but also restrict this process: Every *control shock* before the complete eradication of defective agents can cause the system to break down completely, because in this case the short-term gains of the defectors – who are now more easily able to exploit cooperators – are larger than those of cooperators, and thus defectors take over the population (see figure 7, bottom right panel). However, once there are no defectors in the system any more, also social control becomes obsolete and there is almost no difference to the case of no shock at all. See figure 7 (lower panel) for the dynamics, in particular the difference to a trust shock after 300 time steps.

The similarity of the results for the trust and complete shocks is surprising. It suggests that somehow trust ‘trumps’ social control: The eradication of trust after some time can even serve as a (imperfect) substitute for social control. Once trust is eradicated, there is virtually no situation in which cooperators could be exploited: If a cooperator is chosen for a transaction, she will again contact her associates – who are unlikely to become defectors – and will cooperate with them. If she does not have an associate for this interaction she will – because of her lack of trust – forgo the business. The same is true if she is approached by an agent she has no direct

information about. So the need for social control in such a setting is greatly diminished and the mere *absence of trust serves as a substitute for control* – at least in the protection of cooperators that have already established a number of working relationships. However, the resulting system is still inferior (as cemented at its status quo of relations existing prior to the trust shock) compared to the situation in which both trust and control operate.

In all, trust and social control exhibit a *clear temporal pattern*, which provides us with insights into the mechanisms themselves and their interrelations. Basically, trust and control display some particular complementarity: Existing trust establishes the need for control, later trust may be somewhat dispensable; but only if both are operating simultaneously, the system can realize its potential.

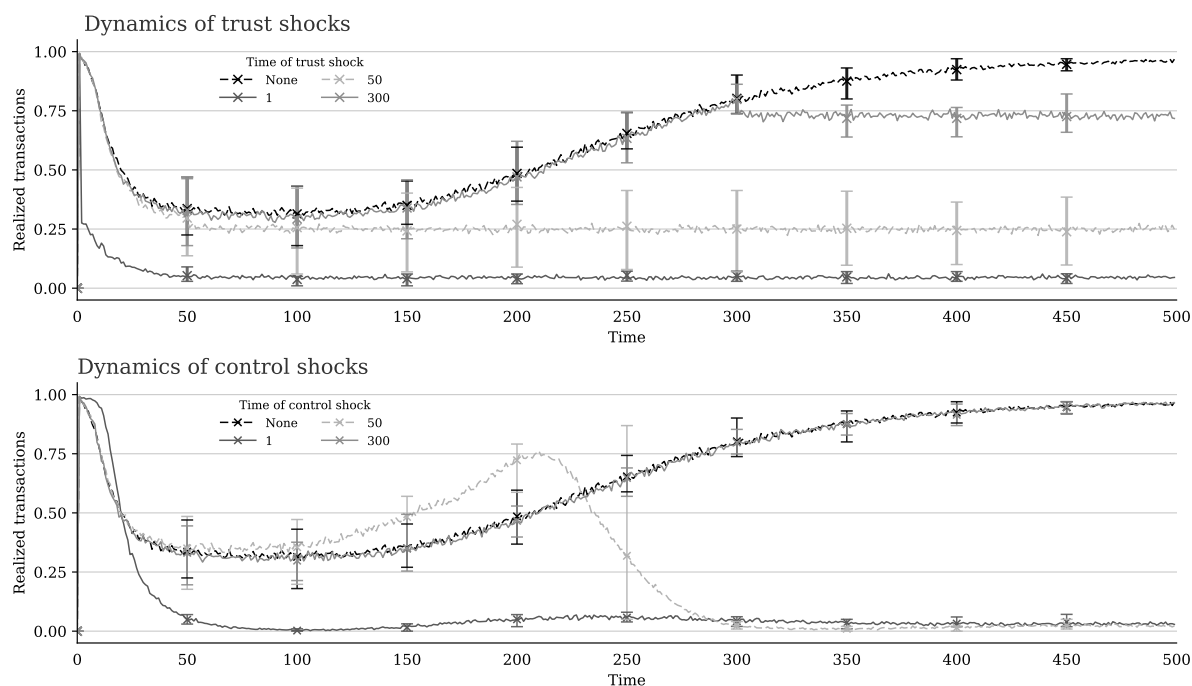


Figure 8: *Adjustment dynamics for the share of realized transactions for different timings of shocks. The results are the averages of 20 simulation runs. Whiskers again indicate 10<sup>th</sup> and 90<sup>th</sup> percentiles.*

### 5.3. The importance of favorable framework conditions

So far we have shown that trust and control are *necessary* for the success of informal exchange systems, and that they are related in a certain temporal structure. We will now see, however, that they are *not sufficient* to ensure a sustainable and successful (let alone an efficient) functioning of the system. There are other factors that are essential for its success as well. Other than for trust and control, however, less favorable conditions of one factor can, to some extent, be

compensated by more favorable conditions of another: in contrast to trust and control the factors discussed here are to some extent substitutable. We now discuss three factors: the number of agents, interaction density, and the ‘forgiveness’ of agents. The OLS results complementing the figures can be found in table 5.

	<i>Dependent variable:</i>		
	Overall efficiency		
	(1)	(2)	(3)
Nb. of hawaladars	−0.127*** (0.015)		
Interaction per period		0.105*** (0.009)	
Resentment period			−0.582*** (0.082)
Observations	40	190	40
R <sup>2</sup>	0.665	0.410	0.568
Adjusted R <sup>2</sup>	0.656	0.407	0.557
Residual Std. Error	20.816 (df = 38)	25.519 (df = 188)	15.755 (df = 38)
<i>Note:</i>		*p<0.1; **p<0.05; ***p<0.01	

Table 5: *The OLS results for the framework conditions.*

*Population size: More agents – more trouble*

As illustrated in figure 9, more agents, *ceteris paribus*, not only seem to reduce the efficiency of the system, but at some point, the system even collapses. Too many agents prevent the mechanism of social control to function properly as cooperators cannot gather enough information on potential defectors in comparison to the increasing population size. The requested knowledge about a new interaction partner’s past behavior simply cannot be discovered and disseminated fast enough and with sufficient probability.

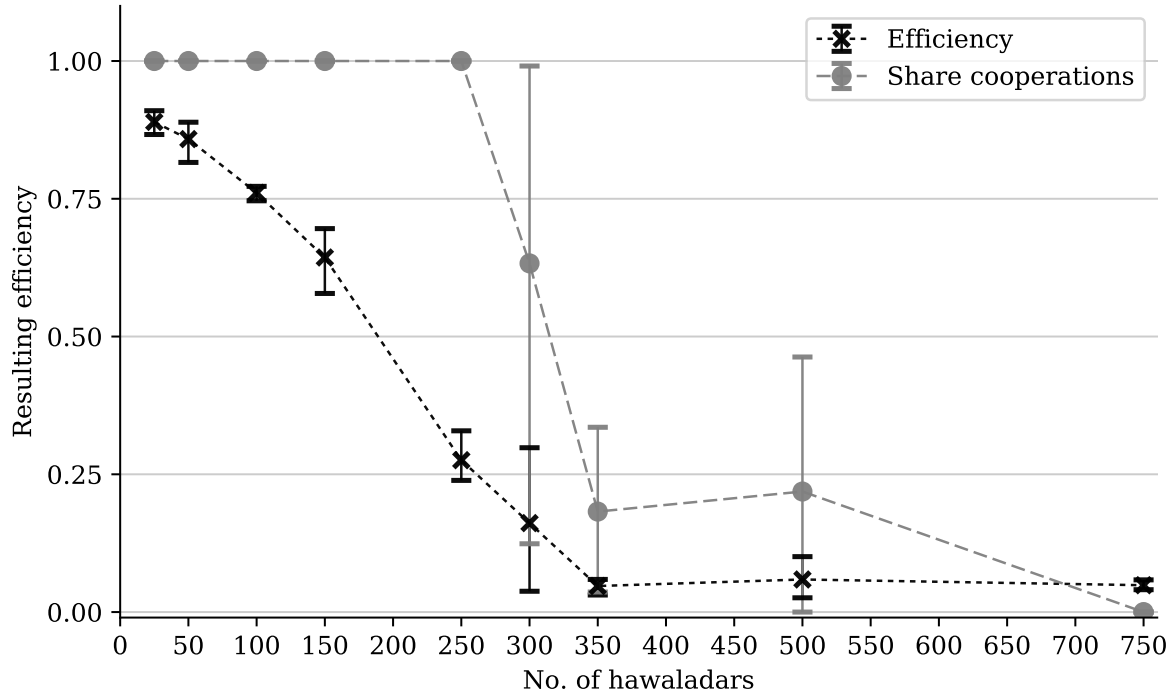


Figure 9: Number of agents that the system can successfully accommodate.

This result comes with a natural interpretation in the context of Hawala: The system can – *ceteris paribus* – accommodate only a limited number of agents successfully through its self-organization mechanisms, due to the underlying *cognitive conditions* of *expectations building*, *memorizing*, *monitoring* and *information diffusion*, as increasing degrees of *anonymity* and *uncertainty* accompany increasing population sizes. Note that we deal with the *relevant population size*, the population or group within a delimitable interaction arena. Obviously, this relates to the factor of *arena or group size* (see Elsner and Schwardt (2013)).

These results, however, beg the question of what determines the number of hawaladars the system can actually accommodate successfully? It turns out that this missing factor is the relative interaction frequency.

#### *Higher interaction density favors cooperation*

As we can infer from figure 10, the more *interactions per period* take place – *ceteris paribus* - the more agents the system is able to accommodate while maintaining a high performance. The intuition underlying this result is similar to the previous one: lower interaction density reduces the ability of the agents to gather information, ultimately used for *social control*. These results align well with previous game-theoretic and evolutionary-institutional modeling of the cognitive, communication, and reputation-related mechanisms required for the emergence of cooperation

(Elsner and Schwardt, 2013), and were corroborated in anthropological, psychological, neuro- and brain-sciences (see, e.g. Henrich et al., (2004) and Gintis (2007)).

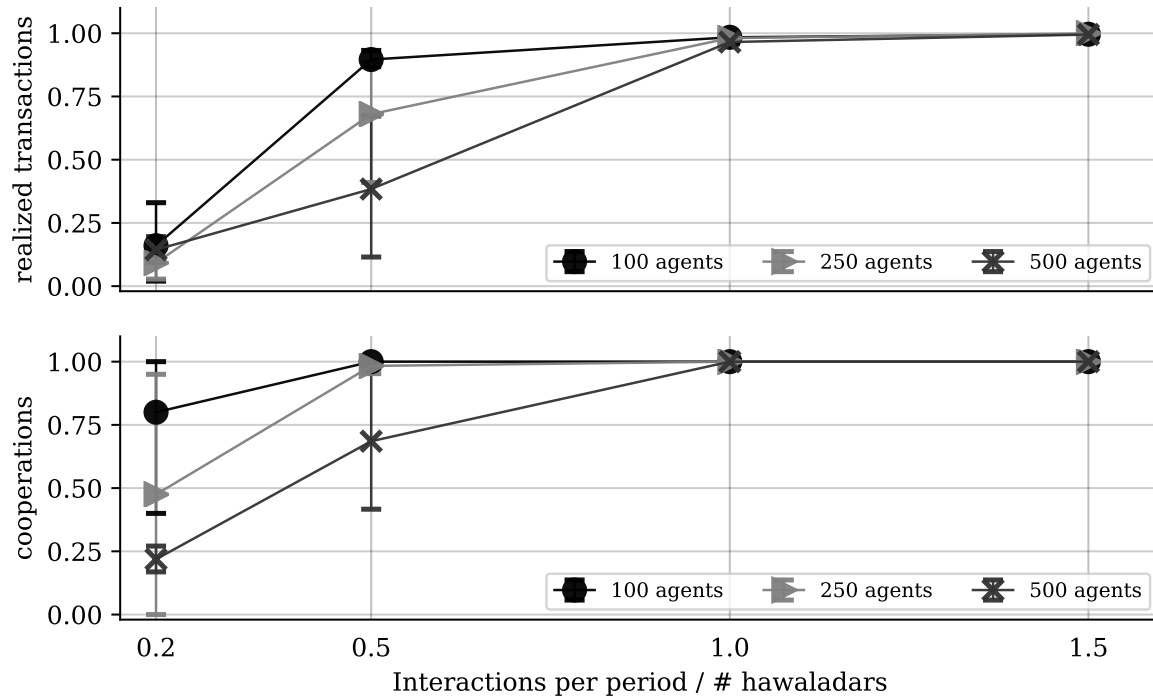


Figure 10: *The higher the interaction density, the more agents can be accommodated by the system.*

### *Forgiveness makes the system more efficient*

After an agent gets exploited, she and her associates will reject the next  $p$  interactions with the exploiter. The number of rejected interactions, until this exploiter is given a new chance, the *retaliation period*, is the inverse of forgiveness, the *propensity to take up cooperation again* by a cooperative agent. This could also be considered the degree of *tolerance* of former defections.

Retaliation/forgiveness has an important effect on the efficiency of the system: If agents do not forgive former defectors, i.e., remember them and refrain from interaction with them for too many periods, the system cannot realize its full potential: former exploiters who have become cooperators do not get reintegrated. Consequently, potential gains from cooperative interactions are not realized (see figure 11, upper panel). As can be inferred from the lower panel in figure 11, a lack of forgiveness does not cause the system to collapse, but makes it inefficient.



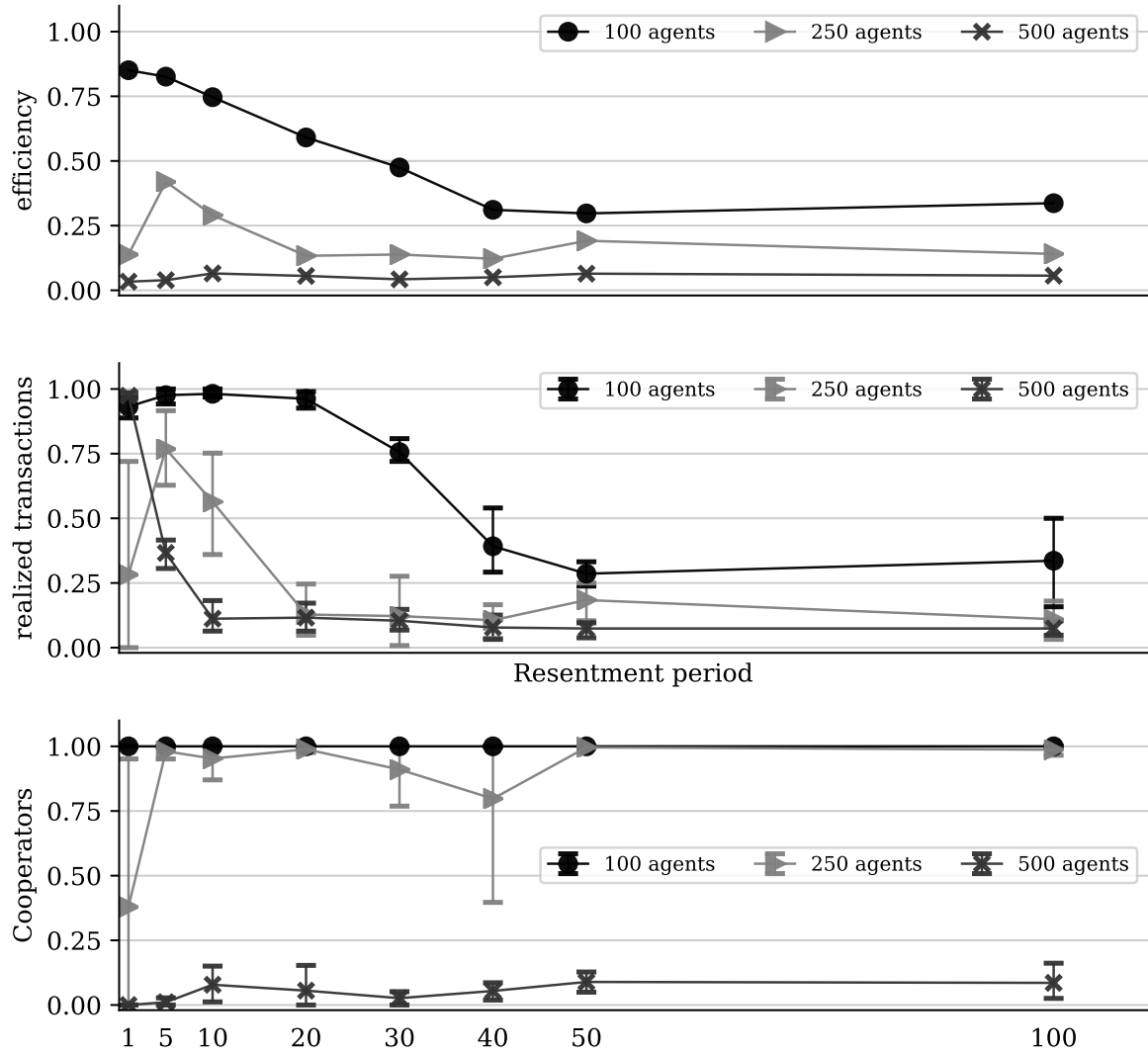


Figure 11: *The role of forgiveness*. Note that forgiveness does not have an impact on the resulting relative level of cooperation but only on the efficiency of the system because fewer interactions are realized.

#### 5.4. Sensitivity analysis

A potential drawback of the method of computational experiments is some lack of transparency, which may quickly occur in simulating complex systems. In our case, however, we can explore the effects of all free parameters on outcomes, as we kept the model relatively simple and thus maintained a sufficient level of transparency. We summarize the results in table 6. Even more detailed sensitivity analyses are discussed in the supplementary material.

The central result that both trust and control are *necessary* for Hawala to function, holds under all reasonable parameter specifications, and is subject only to the dynamic (temporal) results outlined above (section 5.2). However, certain parameter constellations make it considerably

more difficult for cooperation to emerge, so that the emergence of a functioning system – even if trust and control exist – is not guaranteed. We summarize the relevant conditions in table 7.

Parameter	Value, value range	Effect on outcome
Number of agents	50 – 1000	More hawaladars make it – <i>ceteris paribus</i> - generally more difficult for cooperation to emerge. A larger interaction density can compensate this effect.
Initial share of cooperators	25% - 85%	Cooperation emerges for values above 50%. <i>Ceteris paribus</i> , the higher the share, the quicker the equilibrium is reached.
Interactions per period (interaction density)	10 – 500	<i>Ceteris paribus</i> , more interactions per period favor cooperators. Too low values prevent cooperation to emerge.
Rejection period (inverse of forgiveness)	1 – 100	Affects mainly the efficiency of the system: too large values reduce efficiency.
Percentage of agents who update their strategy after a time step	10% - 20 %	Only affects the speed of adjustment towards a particular equilibrium.
Fierceness of the dilemma	$ a/d  \in (0.5, 5.5)$	For reasons explained, we keep $c=0$ . Then, for $d=-2$ or $d=-4$ , we test for different relations of $ a/d $ , keeping $b=2a$ . Results remain stable for most specifications, but adjustment periods take longer if dilemma is fiercer (see the supplementary material).

Table 6: *Summary of the effects of parameter changes.*

As the code for the model is freely available online, the validity of the results may be tested and the model can be easily extended to address further questions. We illustrate how this can be done in the next section.

Necessary conditions: need to be present for the system to function at all	General trust: willingness of cooperative hawaladars to interact with strangers
	Social control: willingness and ability of cooperative hawaladars to monitor and exclude fraudulent hawaladars
Other important conditions: must jointly provide a sufficiently friendly environment for the system to function	Size of population: absolute number of hawaladars may not be too large
	Interaction density: number of interactions per period is sufficiently large
	Forgiveness: period in which former defectors are excluded is not too long.

Table 7: *Summary of the necessary and sufficient conditions for hawala to function and of the impact of the important parameters.*

## 5.5. Extensions

Our model is built in a *modular* way. This means that it is relatively straightforward to extend it and to study the effect of factors not considered in the original model. We illustrate the usefulness of such modularity by introducing two extensions: population growth and decision mistakes. The regression results accompanying the figures can be found in table 8.

	<i>Dependent variable:</i>			
	Real. trans. (1)	Cooperators (2)	Real. trans. (3)	Cooperators (4)
Neutral growth	−0.940 (1.427)	0.000 (0.616)		
Normal growth	−10.940*** (1.427)	−14.534*** (0.616)		
Error prob.			−83.230*** (6.385)	−98.016*** (7.105)
Constant	96.140*** (0.430)	100.000*** (0.186)	31.685*** (1.460)	106.118*** (1.625)
Observations	60	60	240	240
R <sup>2</sup>	0.508	0.908	0.417	0.444
Adjusted R <sup>2</sup>	0.490	0.905	0.414	0.442
Residual Std. Error	3.042 (df = 57)	1.313 (df = 57)	14.465 (df = 238)	16.094 (df = 238)

*Note:* \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Table 8: *The OLS regression for our extensions.*

### *Population growth*

One might expect the model results to change significantly once population growth is allowed for. To test this hypothesis we extend the model – leaving everything else unchanged – we introduce two simple forms of population growth: ‘Neutral’ growth adds new agents with a random strategy, matching the current distribution of strategies. ‘Normal’ growth adds new agents such that there is are 50% chances for them of being cooperators or defectors. As figure 12 shows, such population growth does not change the functioning of the system significantly, only ‘normal’ growth has some very small disturbing influence on the strategy distribution because the newly entering hawaladars have a different strategy distribution than the ones already in the population.

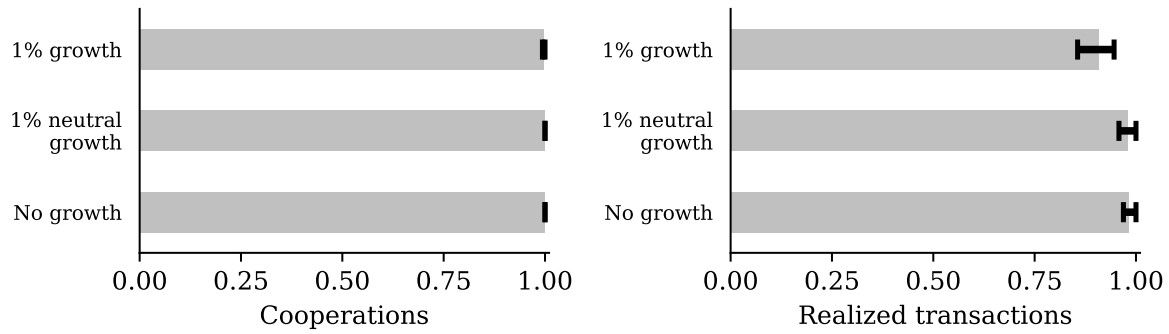


Figure 12: *Simple population growth has no significant effect on the model outcome.*

However, more complex processes of population *turnover* with many entries and exits may have an impact on the system's efficiency, e.g., when less successful agents do not (or cannot, due to lacking information) change their strategies (learn, adapt) quickly enough, but leave the population, thus corrupting the information diffusion system. We leave the study of such more complex questions for further research.

#### *Random mistakes ('Trembling hands')*

Another insightful way to extend the model is to allow agents to make mistakes. Mistakes received much attention in the game-theoretic literature at least since Selten (1975). Here we consider purely stochastic mistakes: With a given probability, cooperators defect upon their interaction partners, or selfish agents cooperate. We might expect that such mistakes have a severe impact on the system since they erode partner selection and, with this, the social control mechanisms. If a cooperative agent defects by accident, she will not be able to interact with her interaction partner and all of the partner's business associates. The results shown in figure 13 confirm this expectation: Even small chances of mistakes significantly reduce the efficiency of the system.

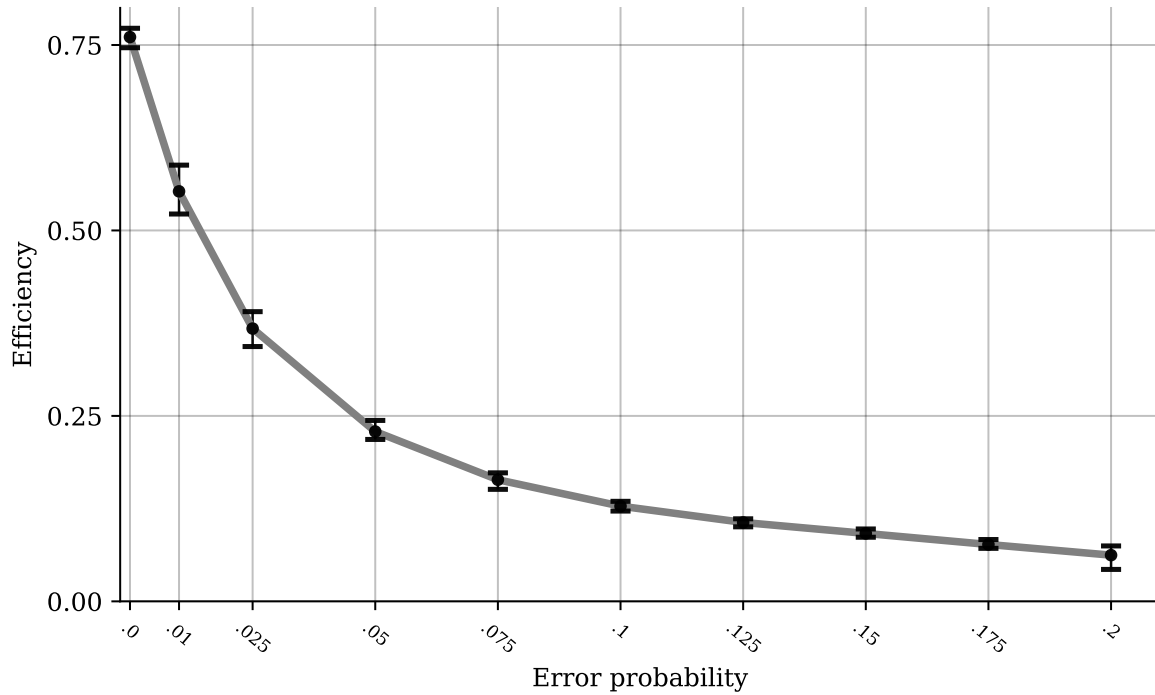


Figure 13: *The effect of stochastic mistakes. Error probability denotes the probability that a cooperative hawaladar cheats by accident, and a selfish hawaladar cooperates by accident.*

How the system deals with potential mistakes may be an issue for further investigation. This may include other forms of mistakes, e.g., mistakes in the processing of information in the monitoring network.

## 6. Discussion

With our computational experiments we contribute to a deeper understanding of the working principles of informal economic exchange systems and of the pathways through which two important institutional self-organization mechanisms, general trust and social control, exert an impact on the systems' functioning. Given opportunities (and often incentives) for agents' fraudulent behavior in a complex, apparently opaque and unenforceable system such as Hawala, the question of how participants coordinate and stabilize their expectations and behaviors and achieve relatively high performance results is of prime interest. The literature has considered the role of general trust and social control in informal economic interactions, but so far, it has been unclear,

- (1) how the two should be operationally defined and operationalized formally,
- (2) which, if any of the two, carries a larger relevance for the functioning of IVTS,
- (3) whether (and when) they relate to each other as substitutes or complements, and

(4) how they interact with a number of other ‘framework’ conditions.

Our model, which, to our knowledge, is the first computational representation of IVTS, particularly Hawala, makes a case for an essentially equal significance of trust and control: In our computational experiments, it was impossible for the system to emerge if either one was completely missing. This supports a basic *complementarity* argument.

In the context of elaborating their *temporal interaction*, our model was helpful in elucidating the mechanisms underlying this relationship: Put simply, general trust is the channel for the emergence of a functioning system, while social control is needed to protect the system in its further evolution against the threats of opportunism.

We also derived some more specific results concerning their dynamic relationship. Both are essential at the beginning of the interactions. After a few relationships have been formed, trust could basically be eradicated from the system without a complete breakdown, but the efficiency of the system would remain considerably low. Trust would become redundant, while performance remained high, only if all agents would know each other from previous interactions. This, however, is unlikely to arise in practice since real-life systems are characterized by an ongoing turnover of agents, incompleteness of information, and other imperfections (of memorizing, monitoring, reputation building, communication, and information diffusion, or random mistakes). Similarly, social control is important as long as the population of agents includes fraudulent players. We found no evidence of a complete crowding-out of either trust or control, with one exception: The absence of trust could serve as an imperfect substitute for social control at a later phase of the development. But this would come at the cost of decreasing efficiency.

We also studied the sufficiency conditions for the system to work properly. While trust and social control are necessary, some other conditions must be sufficiently favorable to allow for reasonable performance and stability. Conditions we have explored in this respect are population size, interaction density, and forgiveness. Here (and in contrast to trust and control), less favorable values for one condition can – to some extent – be offset by more favorable values for other conditions. We found our results to be robust and illustrated the possibility to extend the model by studying, as examples, the effects of population growth (which are negligible) and the possibility that agents make (stochastic) mistakes (which is significant).

While developed for the case of Hawala, our model provides some more general insights. For instance, we explored an operational definition of trust for analytical and computational models (similar to that of Manapat *et al.* (2013)). Our definition not only captures the essential elements of previous definitions of trust and social control, it also aligns well with empirical conceptualizations such as in the *World Value Survey*. When it comes to social control, our definition is also easy to operationalize in both analytical and computational models.

Finally, our results imply interesting policy implications, beyond the usual issues of public control, money laundering prevention, and financial regulation, which currently dominate the discussion of IVTS. Our study suggests options for the stabilization (and high performance) of informal cooperation, which focus on creating framework conditions that support the emergence of trust and social control, and therefore self-organization and self-governance, without formal/legal intervention (for the derivation of a complexity-oriented policy towards informal systems, see, e.g., Elsner (2017)). Such a policy leaves the space for adaptation and evolution taking place in the system of informal interactions among private agents. Policy terms may include providing futurity for interactions to support credible threat of potential sanctioning, shrinking the fierceness of incentive structures and shaping the size of interaction arenas (or relevant groups) in an effort to abate turbulence in accordance with agents' limited cognitive abilities. All this suggests that computational analyses of informal economic exchange systems do have important real-world applications and policy relevance.

## 7. Conclusion and further research

In this paper we contributed to the understanding of IVTS and the functioning of trust and social control in such systems. Our study invites several lines of further research, some of which may be pursued with the computational platform that we have developed here.

In our model specification, each region had the same number of agents, and the sending agent (hawaladar) was selected at random. Both within and across localities, however, we might encounter large agents or higher-level distributors in future research, who create oligopolistic structures. Interactions, system performance, and stability might be very different in networks with few large and many small agents, characterized by gatekeeper functions and right-skewed centrality distributions of hawaladar networks.

Generally, other network structures within the population, such as clusters or particular sub-networks, might modify the process and outcomes. For instance, clusters may ensure and channel cooperation, while powerful gatekeepers may connect different clusters. With both local clustering and long-distance relations, we might further approach real-world network structures. In this way, the model would feature an explicit topology, which may be validated against real-world data.

Further related to the previous issue, the size of particular arenas in which cooperation may emerge has already been indicated to play some role: Smaller arenas do attain cooperation faster. Further, systems of overlapping, layered, and perhaps even hierarchical relations among arenas ('multiplex networks') may modify the interaction results and impact the whole system's resilience. As already indicated, higher turbulence also might be modeled in further studies, for instance, through introducing some turnover in the population via faster entries and exits.

Finally, we did not include the clients' level in IVTS. But local value transfer agents (hawaladars) and clients do have certain interaction structures as well, and even sending and receiving clients may display non-trivial interrelations between themselves. The exploration at this level would, however, require some empirical data, field studies and/or analyzing the features of specific IVTS. Collecting and processing related data will, in general, be an important task for future research of informal exchange systems.

Because our model is freely available, we invite researchers to scrutinize and extend the software to address these issues. But studying the subject with a different methodological approach and relating the results to each other seems to be equally beneficial. In any case, our study has shown that and how informal economic exchange systems rely crucially on social factors and mechanisms that we hope to have enlightened in this paper.

## **Acknowledgements**

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## Literature

- Alvarez, S.A., Barney, J.B., Bosse, D.A., 2004. Trust and its alternatives. *Human Resource Management* 42, 393–404. doi:10.1002/hrm.10097
- Anderson, S., Baland, J.-M., Moene, K.O., 2009. Enforcement in informal saving groups. *Journal of Development Economics* 90, 14–23. doi:10.1016/j.jdeveco.2008.09.003
- Axelrod, R., 1984. *The Evolution of Cooperation*. Basic Books, New York.
- Bachmann, R., 2001. Trust, Power and Control in Trans-Organizational Relations. *Organization Studies* 22, 337–365. doi:10.1177/0170840601222007
- Ballard, R., 2005. Coalitions of reciprocity and the maintenance of financial integrity within informal value transmission systems: The operational dynamics of contemporary hawala networks. *Journal of Banking Regulation* 6, 319–352. doi:10.1057/palgrave.jbr.2340200
- Besley, T., 1995. Nonmarket Institutions for Credit and Risk Sharing in Low-Income Countries. *Journal of Economic Perspectives* 9, 115–127. doi:10.1257/jep.9.3.115
- Bijlsma-Frankema, K., Costa, A.C., 2005. Understanding the Trust-Control Nexus. *International Sociology* 20, 259–282. doi:10.1177/0268580905055477
- Costa, A.C., Bijlsma-Frankema, K., 2007. Trust and Control Interrelations. *Group & Organization Management* 32, 392–406. doi:10.1177/1059601106293871
- Das, T.K., Teng, B.-S., 2001. Trust, Control, and Risk in Strategic Alliances: An Integrated Framework. *Organization Studies* 22, 251–283. doi:10.1177/0170840601222004
- Das, T.K., Teng, B.-S., 1998. Between Trust and Control: Developing Confidence in Partner Cooperation in Alliances. *Acad. of Manage. Rev.* 23, 491–512. doi:10.5465/AMR.1998.926623
- Elsner, W., 2017. Complexity Economics as Heterodoxy. *Journal of Economic Issues*.
- Elsner, W., Schwardt, H., 2013. Trust and arena size: expectations, institutions, and general trust, and critical population and group sizes. *JoIE* 10, 107–134. doi:10.1017/S1744137413000179
- Gintis, H., 2007. A framework for the unification of the behavioral sciences. *Behavioral and Brain Sciences* 30, 1–16. doi:10.1017/S0140525X07000581
- Greif, A., 2006. *Institutions and the Path to the Modern Economy*. Cambridge University Press, Cambridge, UK.
- Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), 2004. *Foundations of Human Sociality*. Oxford University Press, Oxford et al.
- Huemer, L., Boström, G.-O., Felzensztein, C., 2009. Control–trust interplays and the influence paradox: A comparative study of MNC–subsidiary relationships. *Industrial Marketing Management* 38, 520–528. doi:10.1016/j.indmarman.2008.12.019
- Joshi, S., Mahmud, A.S., 2018. Unilateral and multilateral sanctions: A network approach. *Journal*

775 of Economic Behavior and Organization 145, 52–65. doi:10.1016/j.jebo.2017.10.010  
 776 Lambert, L., 2002. Asian Underground Banking Scheme: A Field Note. *Journal of Contemporary*  
 777 *Criminal Justice* 18, 358–369. doi:10.1177/104398602237682  
 778 Lascaux, A., 2015. Crowding Out Trust in the Informal Monetary Relationships: The Curious  
 779 Case of the Hawala System. *Forum for Social Economics* 44, 87–107.  
 780 doi:10.1080/07360932.2014.954250  
 781 Lorscheid, I., Heine, B.-O., Meyer, M., 2011. Opening the “black box” of simulations: increased  
 782 transparency and effective communication through the systematic design of experiments.  
 783 *Computational and Mathematical Organization Theory* 18, 22–62. doi:10.1007/s10588-011-  
 784 9097-3  
 785 Manapat, M.L., Nowak, M.A., Rand, D.G., 2013. Information, irrationality, and the evolution of  
 786 trust. *Journal of Economic Behavior and Organization* 90, S57–S75.  
 787 doi:10.1016/j.jebo.2012.10.018  
 788 Mayer, R.C., Davis, J.H., Schoorman, F.D., 1995. An Integrative Model of Organizational Trust.  
 789 *Acad. of Manage. Rev.* 20, 709–734. doi:10.5465/AMR.1995.9508080335  
 790 Nakhasi, S.S., 2007. Western Unionizing the Hawala: The Privatization of Hawalas and Lender  
 791 Liability. *Northwestern Journal of International Law and Business* 27, 475–496.  
 792 Parandeh, S.C., 2009. Hawala: The fund transfer methodology that evades surveillance. *Journal of*  
 793 *Corporate Treasury Management* 3, 22–32.  
 794 Piccoli, G., Ives, B., 2003. Trust and the unintended effects of behavior control in virtual teams.  
 795 *Manage. Inf. Sys. Quart.* 27, 365–395. doi:10.2307/30036538  
 796 Qorchi, El, M., 2002. Hawala. *Finanzas Desarrollo* 39, 31–33.  
 797 Razavy, M., 2005. Hawala: An underground haven for terrorists or social phenomenon? *Crime,*  
 798 *Law and Social Change* 44, 277–299. doi:10.1007/s10611-006-9019-3  
 799 Rusten Wang, J., 2011. Regulating Hawala: a comparison of five national approaches. *Journal of*  
 800 *Money Laundering Control* 14, 210–224. doi:10.1108/13685201111147522  
 801 Sasaki, T., Uchida, S., 2013. The evolution of cooperation by social exclusion. *Proceedings of the*  
 802 *Royal Society B: Biological Sciences* 280. doi:10.1098/rspb.2012.2498  
 803 Schneider, F., 2010. Turnover of organized crime and money laundering: some preliminary  
 804 empirical findings. *Public Choice* 144, 473–486. doi:10.1007/s11127-010-9676-8  
 805 Schramm, M., Taube, M., 2003. Evolution and institutional foundation of the hawala financial  
 806 system. *International Review of Financial Analysis* 12, 405–420. doi:10.1016/S1057-  
 807 5219(03)00032-2  
 808 Selten, R., 1975. A Reexamination of the Perfectness Concept for Equilibrium Points in  
 809 Extensive Games. *Int J Game Theory* 4, 25–55.

810 Shanmugam, B., 2005. Hawala and money laundering: a Malaysian perspective. *Journal of Money*  
 811 *Laundering Control* 8, 37–47. doi:10.1108/13685200510621181  
 812 Shehu, A.Y., 2004. The Asian alternative remittance systems and money laundering. *Journal of*  
 813 *Money Laundering Control* 7, 175–185. doi:10.1108/13685200410809896  
 814 van de Bunt, H., 2008. A case study on the misuse of hawala banking. *International Journal of*  
 815 *Social Economics* 35, 691–702. doi:10.1108/03068290810896316  
 816 WVS, 2015. World Value Survey 1981-2014 Longitudinal Aggregate v. 20150418. World Values  
 817 Survey Association.  
 818

# Trust and Social Control.

## Sources of cooperation, performance, and stability in informal value transfer systems

### The case of the Hawala money transfer system

## Supplementary Material

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Here we provide more detailed information on the dynamics of our model (S.1.) and present the results of a more extensive sensitivity analysis (S.2.). We also provide a summary of reasons of people preferring hawala over formally established alternatives such as formal banks (S.3.).

## S.1. The dynamics of the hawala

Figure S1.1 illustrates the dynamics of the model for the four baseline cases discussed in section 5.1. As one can see, the model does not show much inter-run variation. The only exception is the share of cooperators in the cases where not both trust and social control are present. The reason for this has been discussed in the paper: Since there are almost no successful interactions, no type of agent persistently outperforms the other. When agents change their strategy (i.e. cooperative hawaladars become selfish and vice versa), no clear pattern emerges.

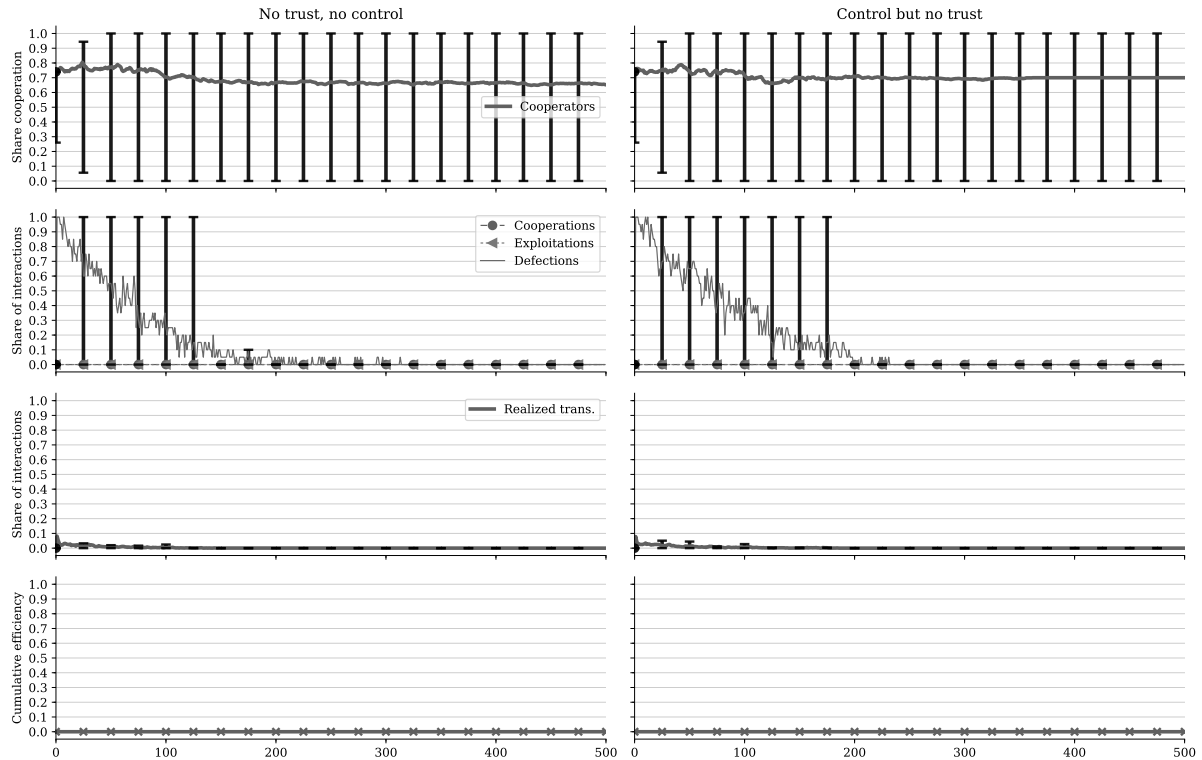


Figure S.1.1. *The adjustment dynamics for the first two baseline cases.*

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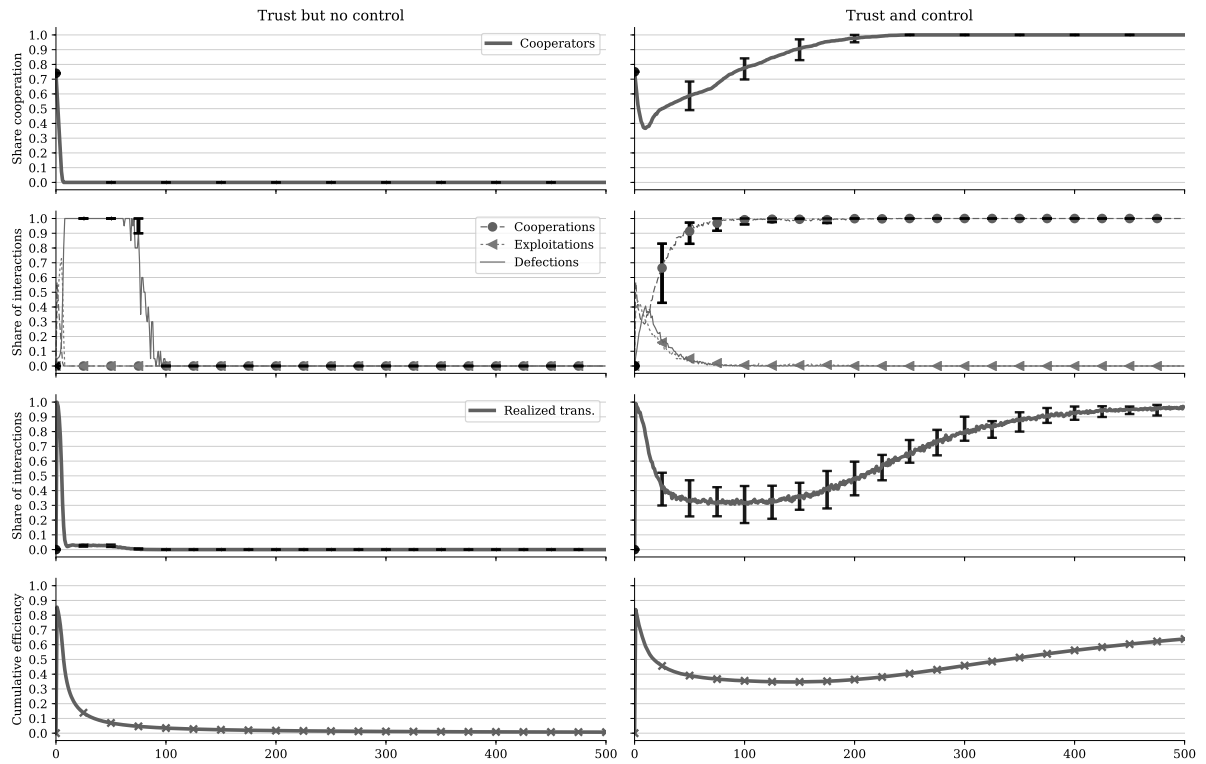


Figure S.1.2. *The adjustment dynamics for the third and fourth baseline cases.*

We now turn to the dynamics of the cases in which shocks hit the system. Figure S1.3 is a slightly extended version of figure S.1.2. and illustrates the causal effect of the shocks on the model dynamics. Again, inter-run variation is negligible.

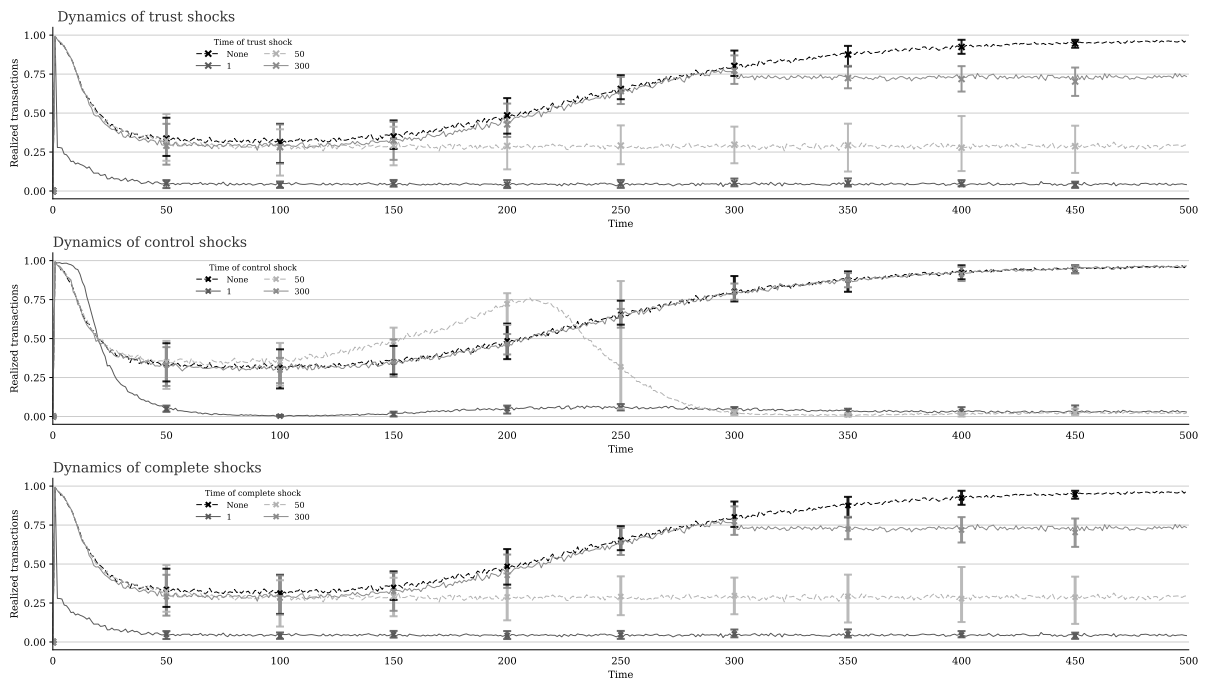


Figure S.1.3. *Dynamics after different shocks.*

Finally, figure S.1.4. again illustrates the similarity between the trust shock and the complete shock. This clearly shows how the trust shock “trumps” the control shock.

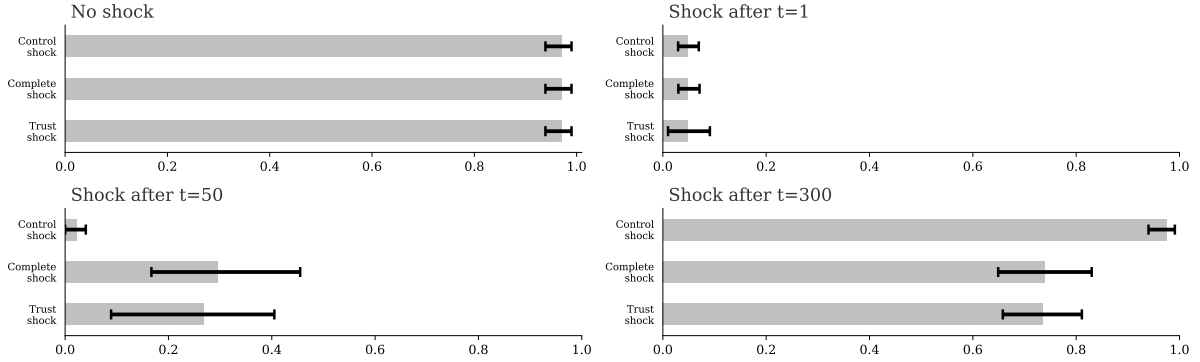


Figure S.1.4. Comparing the results of different shocks. The x-axis denotes the share of realized transactions at last time step (i.e.  $t=750$ ).

## S.2 Further sensitivity analysis

The hawala system is complex and if one wishes to capture all its essential mechanisms in a formal model one has to sacrifice analytical tractability. To partly remedy this drawback, our model has been designed such that the number of free parameter remains as small as possible. We were able to test the effect of every parameter on the model outcome. In effect, while ultimate proofs are not feasible for models as complex as ours, we can say confidently that the model has been fully verified via extensive statistical analysis of the results. Here we present some further sensitivity analyses of our model.

### *The initial share of cooperators*

With regard to the initial share of cooperators we would expect that too many selfish players prevent the emergence of a functioning hawala system. We suppose that real hawala systems with more than 50% selfish hawaladars would not have a chance of survival because they fail to collect a *minimum critical mass* of cooperative agents (c.f. (Elsner and Schwardt, 2013)). Figure S.2.1 confirms this for our model: while a functioning hawala *may* emerge already with about 40% of honest hawaladars in the beginning, only for shares slightly above 50% such an emergence is guaranteed.<sup>4</sup> Notably, it does not matter too much whether there are 55% or 85% honest hawaladars in the beginning. This illustrates the effectiveness of the self-governing mechanisms explored in our study.

<sup>4</sup> This requirement share could probably be further reduced if a stronger form of preferential attachment was implemented.

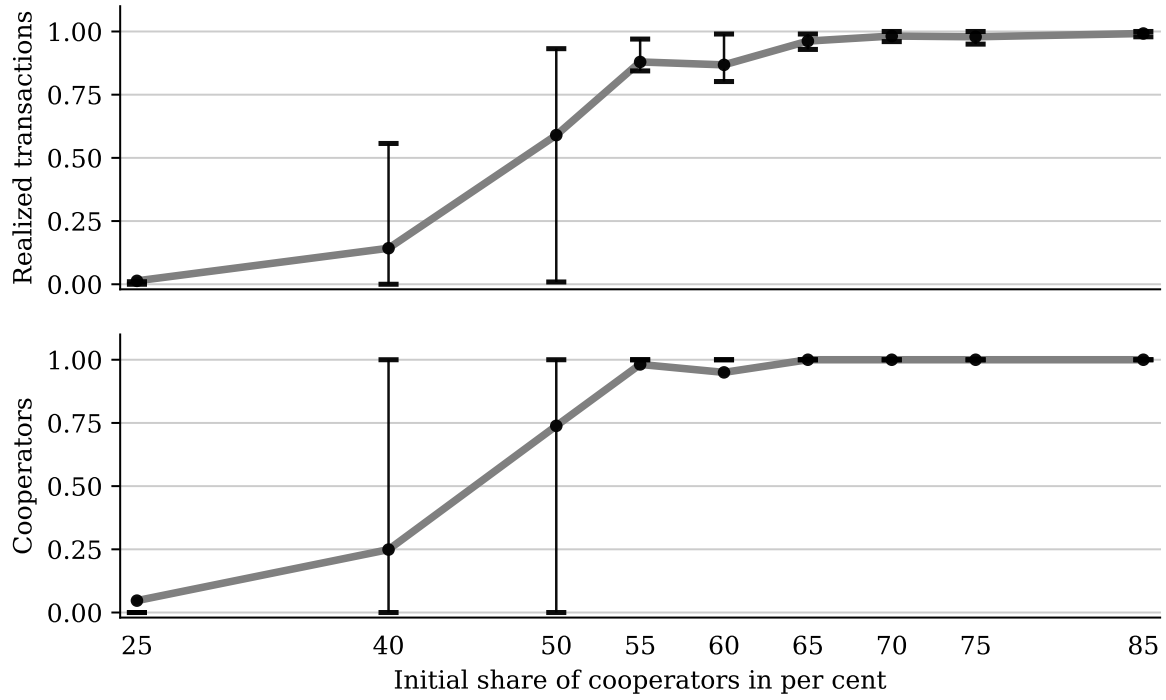


Figure S2.1. *The role of initial conditions: If there are more than 50% cooperative hawaladars in the beginning, the system almost surely functions well. For less than 50% cooperative hawaladars in the beginning, an efficient system is unlikely.*

### *The fierceness of the dilemma*

It is an obvious corollary from game theoretic results that the more intricate the dilemma structure, the more difficult it is for cooperation to emerge and the system to function effectively. In other words: If the relative payoff of betraying the others becomes higher *ceteris paribus*, more agents would be willing to cheat. Because we want to take the perspective of cooperative hawaladars and because we fixed  $c = 0$  (for the reasons discussed in section 4.2) and, following the convention,  $b = 2a$ , we measure the fierceness of the dilemma with the expression  $\varphi = a/|d|$ . The bigger  $\varphi$ , the less dangerous is cooperative behavior for the agent because the payoff of mutual cooperation compared to the loss of being cheated increases.

The results are presented in figure S2.2. We observe that our positive results hold for a wide and sensible range of  $\varphi$  but that hawala cannot function if the cost of getting exploited gets too high. Changing  $\varphi$  is an important entry gate for policies that aim at stabilizing systems similar to IVTS, although changing the game form as such is usually not straightforward. Also changing the game form is usually politically costly, and as a theoretical solution to the problem of Hawala rather trivial.

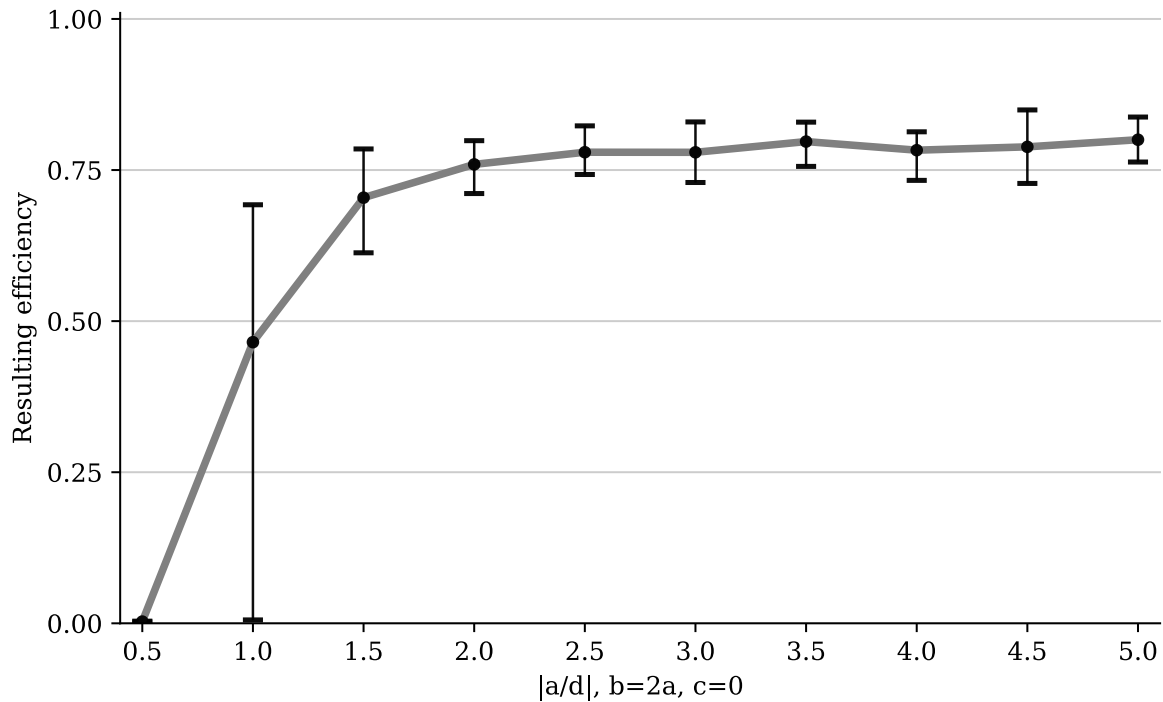


Figure S2.1. *The role of the fierceness of the dilemma: If the loss of getting exploited is too high in relation to the payoff from mutual cooperation, hawaladars do not cooperate enough to build up a functioning system. The value of  $\varphi$  is represented on the x-axis. The bigger  $\varphi$ , the less dangerous it is too cooperate.*

### S.3. Reasons for the competitiveness of hawala

Why do people use an informal value transfer system such as Hawala despite the informality and legal unenforceability of financial claims among hawala participants, the obscurity and impenetrability of the system's workings and plentiful opportunities for getting swindled out of one's money, and despite the existence of well-established rivals, like banks, wire transfer companies and smartphone payment systems?

In fact, Hawala can boast significant competitive advantages over its rivals, particularly in those aspects, which are relevant to its target clientele, migrant workers sending money back to their home countries. Most importantly, Hawala manages remittance flows in distant or dangerous places where the formal banking infrastructure cannot be deployed for security or profitability reasons. Hawala networks offer an equally suitable option for those customers in the developing countries who lack trust in the official banking services or cannot consume them due to illiteracy, inadequate transportation means or missing paperwork (Razavy, 2005). Hawala is less expensive than competing mechanisms of money transfer, with low commission fees and favorable



exchange rates being sustained through the lower overhead and compliance costs (Liargovas and Repousis, 2011; Qorchi, 2002; Shanmugam, 2005; Viles, 2008; Zagaris, 2007).

This alternative fund transfer system also proves to be fast and reliable, reaching most international destinations within hours rather than days (Qorchi, 2002; Zagaris, 2007) and avoiding suspicious losses in transit (Shanmugam, 2005), as hawaladars prize and strive to maintain their reputation for speed, efficiency and trustworthiness (Nakhasi, 2007; Razavy, 2005; Viles, 2008). Other benefits of Hawala networks include informality (in contrast with mobile or wire transfers, no registration is needed and money can be sent under an assumed name), spatial and temporal flexibility in accommodating customer demand, cultural affinity with hawaladars and a sense of personal interaction between the sender and intermediary (Liargovas and Repousis, 2011; Passas, 2005; Qorchi, 2002; Razavy, 2005; Zagaris, 2007).

These comparative advantages of Hawala over conventional fund transfer systems far outweigh its potential drawbacks, such as the lack of tangible evidence that a transaction has actually occurred or the necessity to deal with intermediaries who typically operate ‘out of nondescript little shops and bazaars’ (Shanmugam, 2005).

## References

- Elsner, W., Schwardt, H., 2013. Trust and arena size: expectations, institutions, and general trust, and critical population and group sizes. *Journal of Institutional Economics* 10, 107–134. doi:10.1017/S1744137413000179
- Liargovas, P., Repousis, S., 2011. Underground banking or hawala and Greece - Albania remittance corridor. *Journal of Money Laundering Control* 14, 313–323. doi:10.1108/13685201111173794
- Nakhasi, S.S., 2007. Western Unionizing the Hawala: The Privatization of Hawalas and Lender Liability. *Northwestern Journal of International Law and Business* 27, 475–496.
- Passas, N., 2005. Law enforcement challenges in hawala - related investigations. *Journal of Financial Crime* 12, 112–119. doi:10.1108/13590790510624963
- Qorchi, El, M., 2002. Hawala. *Finanzas Desarrollo* 39, 31–33.
- Razavy, M., 2005. Hawala: An underground haven for terrorists or social phenomenon? *Crime, Law and Social Change* 44, 277–299. doi:10.1007/s10611-006-9019-3
- Shanmugam, B., 2005. Hawala and money laundering: a Malaysian perspective. *Journal of Money Laundering Control* 8, 37–47. doi:10.1108/13685200510621181
- Viles, T., 2008. Hawala, hysteria and hegemony. *Journal of Money Laundering Control* 11, 25–33. doi:10.1108/13685200810844479
- Zagaris, B., 2007. Problems applying traditional anti - money laundering procedures to non - financial transactions, “parallel banking systems” and Islamic financial systems. *Journal of Money Laundering Control* 10, 157–169. doi:10.1108/13685200710746866