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Is Prosocial Behaviour Contagious On Social Media Platforms?

A Gift Giving Intervention in an Online Gift Exchange System

Thesis Master Behavioural Economics

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Abstract

The study of social influence mechanisms in the field will be central to explore their relevance for human cooperation and possibilities to design context specific instruments targeting overall welfare while bridging between theory, lab findings and concrete applicable approaches. This field experiment addresses these aspects by investigating the contagion of prosocial behaviour in a transparent online environment and estimating the impact of a gift giving intervention on strangers. Employing a simple difference in differences method, two online gift exchange systems are observed as treatment (Aachen, Germany) and control group (Duisburg, Germany) over a two month period. Thus group members are observed in a natural environment while being unaware of the experiment taking place. Behavioural predictions are based on an integrative model for social contagion which describes structure and social influences of information-flows generated by group activity. Since moderating factors are key for social contagiousness a qualitative analysis of the online environment and proxy data on individual attributes supplement the analysis and provide a framework to put findings into perspective. Interestingly and in contrast to previous findings no support for contagious prosocial behaviour is found even after controlling for behavioural dynamics. Implications for future field and lab experiments are discussed alongside several design issues of this pilot study.

Keywords: Social intervention, Social contagion, Social influence, Cooperative behaviour, Upstream reciprocity, Third-party influence, Online networks

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Front picture: Beatriz Gerenstein, The Gift. Installation at the exhibition Personal Structures during the 58th Venice Biennale, Venice, Italy. Organized by the European Cultural Centre. May 11 to November 24, 2019. Palazzo Mora, Venice, Italy

Contents

1 Introduction

Even when the relevance of direct reciprocity and social reward is low, people often behave prosocial and cooperative when interacting with strangers.[1] One possible explanation that has been explored in recent years is that prosocial behaviour is contagious. Social contagion describes the diffusion of behaviours spreading from one individual to another via differing social influence mechanisms. Thus due to being exposed to prosocial behaviour individuals accordingly change their behaviour in independent future interactions. In the absence of strategic incentives, prosocial behaviour had been observed forming self-enforcing and cascading dynamics [2] across social contexts [3]. Thereby, the relevance of specific social influence likely varies across settings [4]. Past research found strong support that prosocial behaviour mediated by observing or directly benefiting from it, increases others prosocial behaviour in a large variety of experimental settings [5, 1]. Nevertheless the effectiveness of social influences depends crucially on circumstantial moderators. [6]. This requires further testing of norm-based mechanisms underlying the contagion of prosocial behaviour in the field [7].

This field experiment investigates the contagion of prosocial behaviour (CPS) in a transparent online environment with strangers. Subjects are unaware to participate in an experiment. Employing a simple difference in differences method, we observe two online gift exchange systems (GES) as treatment (Aachen, Germany) and control group (Duisburg, Germany) over a two month period. In online gift exchange systems, subjects are part of a locally bounded group on a social media platform. Individuals engage in giving and requesting gifts among each other by sending corresponding public posts into a group channel. The basic idea of such peer-to-peer good allocation systems is to provide a platform for facilitated gift exchange among strangers. Online GES became surprisingly successful in recent years and had been increasingly subject of research. Examples for investigated online GES range from the student service exchange Kessi [8, 9] with approximately 4000 members up to the website Freecycle (USA) with almost 10 million members [10, 11, 12, 13]. On social media platforms gift exchange groups deliver similar services compared to Freecycle and Kessi. For the purpose of this study, we observe *Freeyourstuff-groups* on Facebook and explore the potential of online GES as a platform for behavioural field experiments. The special transparency of the setting allows to gather additional information about moderators of CPS and individual attributes. [2]

The goal of this study is to encourage proactive gift giving among strangers by providing additional gifts who are distributed within the first two weeks of the treatment period. Due to treating one group with additional gifts, group members experience gift giving by directly benefiting from it meanwhile the group as a whole observes increments of gift giving in the group. The central hypothesis tests whether social influences increase gift giving on Freeyourstuff-Aachen compared to Freeyourstuff-Duisburg. Based on prior experimental and theoretical work [7] we model and test upstream reciprocity and third party influence as potential channels underlying contagious behaviour in an online GES environment. Nowak & Roch [18] defined upstream reciprocity as willingness to cooperate in dependence on one's own experienced cooperation in the past. The more frequently an individual benefited from cooperation of other network members in the past the higher willingness to act cooperative one-self. Third party influence refers in this case to an increased likelihood of gift giving after observing another individual

[1] Cooperative behaviour: Benefiting a collective and contributing to a public good. prosocial behaviour: Individual act that benefits one or multiple others. [1]. Note that for these definitions cooperative behaviour is always prosocial but not vice versa.

[2] Such groups count at present date (2020) up to 40.000 (Frankfurt) in exceptional cases even 167.000 (Berlin) members[14, 15]. For this experiment we choose smaller groups with approximately 1000 members [16, 17].

acting prosocial. As an informational influence, it spreads via a descriptive norm signal by an insignificant other (a stranger). Another type of third party influence is peer influence. It spreads as an injunctive norm signal send by peers such as friends and family[3] [19]. In addition of testing the CPS of gift giving behaviour in isolation we also include other behavioural dynamics such as gift-request and spamming into our analysis. Moreover, we analyse environmental features of social contagiousness useful for identifying advantageous and disadvantageous moderators embed in the field setting. Finally we provide proxy data on individual attributes and group growth dynamics during the observation period. This is especially relevant to discuss the social contagiousness of both groups relative to each other and the central parallel trend assumption. Interestingly we do not find support for the role of CPS in online GES even after controlling for behavioural dynamics. Implications and directions for future field experiments in the context of online GES are discussed.

This study contributes to current research by applying social contagion theory and insights from laboratory experiments in a policy relevant context. We carry out a social intervention to promote prosocial behaviour among strangers interacting in an online community. Thereby, this study provides insights about upstream reciprocity and third party influence in a complex and dynamic social media environment. Field studies focusing on social interventions to promote cooperative and prosocial behaviour let suggest that norm-based mechanisms can be highly effective and cost efficient compared to classic incentive systems but heavily depending on social context [6]. Anticipating this, influential moderators of social contagiousness are identified and reported in order to reduce ambiguity of social network structure. Moreover, the promotion of generalized exchanges in society as attempted in this study is desirable from a governmental welfare perspective. Generalized exchange builds social ties more effectively compared to direct exchanges [20, 21]. Online GES such as free your stuff groups institutionalize generalized exchange among strangers which establishes trust [8, 9] and civic engagement [11] in society. Despite this, the ecological redistribution of goods without (monetary) utility to their owners embed in an online social context is relevant for socio-ecological habit formation (see Aptekar 2016 [10] on the Freecycle network).

2 Literature Overview

This overview discusses literature focusing on the social contagion of prosocial behaviour (CPS). Further, we review selected literature that identified framing moderators who are likely to influence the degree of social contagiousness in specific online environments. Hence an emphasis is put on experimental settings and online interaction environments. Generally, the spread of norm-adaptive behaviour is well documented across various disciplines ranging from sociology, psychology and behavioural economics providing support for the existence of social influences inside and outside the laboratory [6, 4, 5, 1]. However, field experiments aiming at applying specific descriptive and injunctive norm mechanisms via social interventions revealed that behavioural contagion depends substantially on moderating environmental factors [6]. An Initial study on the social contagion of cooperative behaviour provided experimental evidence for the spread of cooperative behaviour. Fowler and Christakis (2010) [2] used data from a sequential one-shot Public good game (PGG) designed to investigate the effect of altruistic punishment on the stability of cooperation. In the analysed PGG individuals were randomly assigned into groups of 4 without knowing each other's identity. Participants played a total of 6 consecutive rounds whereas groups were reshuffled at the beginning of each

[3]Descriptive norms are regularities of behavior, reflecting what most people do in a given situation, whereas injunctive norms are behavioral expectations that are backed by (social or material) punishment or approval [1]

round such that none of the subjects played repeatedly. In the game, each player obtained 20 monetary units which he could either decide to keep or invest into a public pool. Afterwards the total sum of the public pool was multiplied by 0.4 and each player obtained the total amount from the pool in addition to what he decided to keep. In this setting, the social optimum is achieved if each player invests the total amount of his budget but players are incentivized to deviate from contributing to increase their income. At the end of each round, players obtained reports about the contribution of others before the start of the next round ([22, 2]. For the initial control group without punishment, each additional monetary unit shared by a group member in round 1 directly caused the remaining three players to increase their contributions by a mean of 1.8 units in the following rounds. Moreover, cooperation spread on to the second degree of separation. The initial increase in the first period caused 9 further players to increase their contributions by a mean of 1.2 units at the second degree of separation between round 3 and 6. In total, an additional unit in period one tripled over the course of 6 rounds (insignificant results for round 4 and 6). When punishment from an observer was possible, cooperative behaviour spread one degree further on to three degrees of separation from round 4 till 6. Fowler & Christakis (2012) [2] comment that the observed pattern fits well with behavioural implications of upstream reciprocity. CPS can also spread across differing social contexts. Peysakhovich & Rand designed a 2-stage-experiment in which individuals first played prisoners dilemmas with each other. At the second stage of the experiment prosocial value orientation was measured using a dictator game. Subjects who experienced cooperation in the prisoners dilemma acted more prosocial in the dictator game and scored higher on the world values survey [3].

In the settings discussed so far it is not possible to isolate underlying social mechanisms driving the contagion of cooperation because individuals experience and observe cooperative behaviour simultaneously. Not only in PGG but also in sequential dictator games descriptive and injunctive influences favour other-regarding offers. Results let suggest that fairness rather than generosity is paid forward [23, 24]. In the game designed by Cason & Mui 1998 [23], a seller set a price between 0$ and 40$ and made an irrefutable offer to a buyer. In the treatment sellers obtained information about an offer made by another seller in a previous round. This represents an informational third-party influence. If the displayed offer was generous or fair (20$ or lower), sellers offered smaller prices compared to the control group in which irrelevant information about another individuals birthday was provided. Thus, people behaved more prosocial when being exposed to third-party influence receiving information about another person offering a fair price. In a framed field experiment Gray, Ward, & Norton (2014) [24] designed a sequential dictator game in a subway station. By-passers received a first envelope that contained between 0$ and 6$ and were told that a former by-passer left this share for them and kept the rest. An injunctive influence testing upstream reciprocity. Shares were manipulated by the experimenters to be either generous (¿ 3$), fair (= 3$) or greedy (¡ 3$). After receiving the first envelope, individuals could decide themselves how much to keep and how much to pass on to the next bypasser while keeping the rest. Greedy shares were contagious and passed on to the next person but also fair shares were passed on. In line with upstream reciprocity, fair and generous shares resulted on average in fair shares passed on to the next person (see also Ben-Ner et al. (2004) [25]).

Tsvetkova & Macy (2014) [7] conducted a web-based experiment and designed an unidirectional sequential gift game setting similar to the dictator game. The authors studied upstream reciprocity and third party influence as impact factors moderating prosocial behaviour. In the experiment subjects paid 0.20$ to get accepted to a subject pool containing 150 subjects on Amazon Mechanical Turk.[4] Experimenters selected a

[4]A Crowd-sourcing online market enabling researchers to gather a subject pool for behavioural experiments. See Rand et al (2012) for additional information [26]

seed fraction of the pool and invited subjects to perform a task for 2-3$. Seed subjects were informed about being invited by experimenters and offered a choice to sacrifice a bonus payment in order to invite an additional participant from the pool to perform the task. Subjects invited to the task were informed about being invited by another participant and could also choose to sacrifice their bonus payment in order to invite another individual. This way subjects participated on average 2.1 times in the task. Upstream reciprocity was tested by comparing giving behaviour of seed subjects to those who had been invited by other players when playing the first time. In line with upstream reciprocity, the authors find that being informed of an invitation by another player increases the probability of donating one's own bonus to another player relative to the seed fraction. This effect does only hold for one invitation by the recipient and disappears for additional invites. The authors hypothesize that recipients may have felt that they fulfilled their moral obligation to give back. The authors moreover suspect that the display informing subjects of being invited by either experimenters or other participants represents a relatively weak stimulus due to a lack of visibility. Participants were informed about being invited by an additional sentence in the information window which explained the task. In order to test third party influence, an observation treatment was included that allowed subjects to observe the number of times other subjects chose to give away their bonus in previous rounds (including a list showing the pairings of giver and receiver). Third party influence was tested between seeds in the observation treatment compared to those who were not. Observing between 0 and 75 cooperative behaviours increased the odds of donating by 4.3 percentage points relative to the baseline category. Observing more than 150 cooperative behaviours decreased the estimated odds of donating. In case subject observed between 75 and 150 others acting prosocial no significant relationship to the treatment had been found. The authors interpret their finding as approval for an u-shaped effect of third party influence a result of an encouraging norm signal on one hand and a diminishing by-stander effect on the other as the number of observed prosocial behaviour increases beyond the optimum.

When studying behavioural contagion, the given strategy space is likely to moderate the degree of contagiousness of specific behaviors. Observing multiple strategies simultaneously makes social contagions more complex and ambiguous. Different types of behavioural strategies may relate complementary, competitive or neutral to each other [27]. Not only cooperative and prosocial behaviour but also defective and anti-social behaviour (cheating [28]) can be contagious in the laboratory [3, 29, 30, 31], field [32, 24] and online [33, 34]. In a field study Keizer, Lindenberg & Steg (2008)[32] observed individual behaviour in public spaces who were either marked by prosocial or anti-social behaviour. Individuals within anti-socially marked public spaces engaged correspondingly in more anti-social behaviour. In online social contexts in multiplayer games, being exposed frequently to cheating behaviours increases the likelihood of becoming a cheater oneself [33, 34]. In the PGG design, cooperation and defection relate typically adverse to each other. Cooperation and defection result from contribution decisions on a continuous scale of monetary units. Giving a lot is cooperative but risky whereas giving few is defective but safe. Previous studies who analysed the contagiousness of defection and cooperation simultaneously found that defection had relatively more impact on others monetary contributions compared to the spread of cooperative behaviour [31, 29]. It is likely that prosocial and anti-social behaviour that diffuses through the same network channel competes with each other. As a result either cooperative or defective behaviour may be perceived salient whereas the other is neglected or attenuated [27].

In contrast to the discussed PGG dilemmas in this overview, in Tsvetkova and Macy's (2014) [7] design individuals did not observe defective behaviour such that potential adverse interactions of both competing strategies were excluded (the number of people who decided not to sacrifice their bonus was not reported to individuals). This also

applies to the discussed dictator games in which either prosocial or defective behaviour was observed [24, 23]. Studies testing the social contagion of cooperation in PGG settings similar to Fowler & Christakis (2010) [2] replicated these results only partially. In online PGG settings cooperation was contagious but did not spread beyond the first degree of separation [30, 29]. Investigating cooperation cascades in the laboratory Liu et al. (2015) [31] tested social contagion of cooperation in a 2 player setting using consecutive PGG one shot scenarios. The authors found that playing with a modified seed bot who contributed the whole budget increased giving behaviour in the next round. This effect was attenuated relative to the findings of Fowler & Christakis (2010) because increased giving behaviour did not spread on-wards from this stage either. Analysing randomly matched sequential 2 player prisoner dilemmas Duffy & Ochs (2009)[35] do not report the spread of cooperative norms at all. Finally, Capraro & Marcelletti (2014) find that neither cooperative behaviour in PGG nor in dictator games is contagious driven by upstream reciprocity [36]. Thus, results for CPS in regard to reach and effect size of CPS across similar types of strategy spaces are mixed.

It is likely that *decision context* and *structural features* of a specific social network moderate the mechanisms of CPS. This applies to general network characteristics details of decision contexts as well as to details of the decision context. Turning to network characteristics, Yamagashi and Cook (1993)[37] investigate two types of generalized exchange systems in a repeated partner-setting:[5] Network-generalised exchange (A)) and group-generalized exchange (B)). A) refers to a system of generalized exchange in which person A gives to B, B gives to C and C gives to A. B) refers to the exchange structures of PGG dilemmas in which individual resources are pooled and later distributed to a group. In the network generalized exchange condition groups of 4 could choose to donate their budget to the person next to them. This budget would then be multiplied by a factor 2. In the group generalized exchange condition groups of 4 played an equivalent public good game with equal payoffs. In their experiment, Yamagishi & Cook (1993) [37] observe higher and more stable levels of prosocial behaviour in network-generalised exchange systems. The authors argue that individuals experience higher degrees of feeling responsible for the benefits of one specific group member relative to individuals in group-generalized exchange systems in which responsibility is more likely to diffuse when other members act cooperative. The two settings differ also in their implicit framing of the public good. Whereas individuals in PGG contribute explicitly to a public good that produces benefits , in network-generalized exchange gifts are transmitted. Framing public good contributions as gifts can be likewise advantageous for prosocial behaviour [38]. Yamagashi and Cook (1993)[37] used partners conditions to compare network-generalized and group-generalized exchange. Greiner et al. (2005) find that in network-generalized exchange (which they call cyclical indirect reciprocity) strangers compared to partners cooperate less but still cooperate in line with upstream reciprocity [39].

Jordan et al (2013) [29] studied the impact of network *dynamics* (the degree to which members of a network leave and join a network game) on the social contagion of cooperation in a PGG. Each group consisted of several networks who's size was kept fixed in each group at an average of 20. Amongst others, one treatment was computed by assigning 20 percent of a group to another network after each round. The authors found that cooperation and defection can be both contagious in fixed networks whereas in dynamic networks only defection remained contagious. The authors interpret their findings as support for the intuition that in dynamic networks cooperative subjects choose to cooperate independently from previous experiences in order to attract new neighbours. Studying differing degree distributions (probability distribution of the number

[5] Groups are fixed and thus effects of social contagion are confounded with social learning bound into one specific social group context. Anticipated rewards play a role in stabilising cooperation.

of direct connections individuals share with others) Suri and Watts (2011) [30] found only marginal effects driven by network structure in online based PGG. Each network type consisted of 24 players. The networks differed by k connections among players within a specific network cluster. Individuals were directly connected with each other by means of provided information about past contributions. When inserting unconditionally cooperating bots into an PGG session cooperation was directly contagious but did not spread any further regardless of degree distribution. Despite the distribution of connections also their strength moderates contagiousness within a network. In a framed field experiment, tie strength among individuals increased their willingness for prosocial behaviour and trust (Harrison, Sciberras, & James (2011)[40]. The authors mapped a real-world social group via surveys and tested their willingness to invest effort into unpleasant tasks to benefit others and themselves. Tie-strength predicted willingness to invest effort even when direct reciprocity was not present. In online networks individuals form multi-layered social tie structures consisting of multiple clusters. Individuals can be connected with each other via friendship relationships and shared group memberships likewise. In network analysis of social media platforms friendship connections are not a good predictor of tie strength due to the facility of establishing this tie label [41]. Xiang et al (2010) [41] estimated tie strength on a social media platform using interaction frequencies, time duration and social cues as predictors of tie strength. Literature on gift giving highlights specifically perceived similarities between giver and receiver as a strong predictor of willingness to give [42, 43]. Lastly, group size effects are likely to play a role for the contagiousness of prosocial behaviour. In a meta analysis of 375 studies on linear public good games, Zelmer (2003) [44] finds that group size is insignificant overall. However, group size effects on public good provision may be non-linear and in fact be curvilinear [45]. Nosenzo, Quercia & Sefton (2015) [46] studied the effect of group size for small groups by means of an PGG with fixed groups over ten periods. The authors find that cooperation is most stable for groups if N = 2 and relatively fragile if N = 8. For large groups this adverse effect of group size reverses. Isaac, Walker & Williams (1994) [47] studied group size effects in public good provision for groups of 4, 10, 40 and 100. Groups of 40 and 100 provided the public good better and subjects behaved more cooperative compared to groups of 4 and 10. Also in one-shot interaction scenarios group size of 40 compared to 4 players seems to favour cooperation in PGG dilemmas [48].

Also *visibility, decision time frame* and the amount of available *social cues* are central features of social contagiousness in online environments among strangers. Hodas & Lermann (2014) [49] developed a framework considering visibility, divided attention and limited cognitive capacities. The authors investigated social contagiousness in complex multi-message environments on two social media platforms (Twitter and Diggs). When increasing visibility of specific messages by manipulating size and central display position in the user interface, individuals reacted more often upon them by re-posting and responding to them. Despite visibility, the decision time-frame is likely to moderate the contagiousness. Rand & Cone (2014) [50] found that narrow time-frames have an advantageous effect on cooperation implying an intuitive prosocial heuristic. This positive effect of time pressure holds even when the complexity of social cues is increased regardless of whether the dilemma is framed as competition or collaboration [51]. Research on CPS with broader decision time frames merely relies on natural occurring data. Research in this field (including this study) cannot be generalised as it suffers from homophily when studying social contagion [52]. Van Appeldorn & Schram (2016) [53] studied upstream reciprocity in an online service exchange system by creating accounts with differing levels of serving history. Here, the authors did not find evidence for upstream reciprocity. Kizilcec et al. (2018) studied online gift giving behaviour in a friendship network on Facebook. In order to control for homophily the authors choose

an individual level interrupted time series model. In line with theoretical implications of upstream reciprocity and peer influence (observing behaviour from significant others such as friends), individuals are found to be more likely to give a gift to someone else after their own birthday. Under laboratory conditions even weak *social cues* can cause significant increases in willingness to give to strangers [54, 55]. In dictator games revealing the family name of the receiver increases willingness to give compared to anonymity as investigated by Charness & Gneezy (2008) [54]. Also showing abstract depictions of faces during the dictator's decision has a positive impact on transmitted shares [55].

3 Field Setting

The gift exchange systems in Aachen and Duisburg are organised on the social media platform Facebook and are part of the "free-your-stuff" initiative. Known mechanisms who favour the emergence of cooperation such as direct reciprocity, reputation building, reward or punishment are unlikely to play a role within voluntary interactions. Group members do know each other's identity but meet as strangers in one-shot encounters when transmitting goods. Yet such groups are often stable and growing in online environments. In this section we specify the structural form (3.1) and special features (3.2) of the field setting and rely on theory in order to analyse advantageous and disadvantageous moderators of social contagion.

3.1 Structural Exchange Features

The structural form of gift exchange in Freeyourstuff-groups is characterised by 2-step bilateral interactions between group members whereas the first step is always observed by the public. First a group member posts a public message into the group in order to either request or offer. Thus the population of a Freeyourstuff-group is connected without any frictions whereas messages spread from peer to network. Consecutively, others can choose to react up on those messages. Second, the messenger can choose to respond and set up a date for a face to face transaction by using private communication. These peer-to-peer encounters and relate to one-shot interaction scenarios as the probability of re-encountering each other is low. Giving (gift selection and opportunity costs) and receiving (pick-up costs) does bare transaction costs.

Generally, the exchange structure of Freeyourstuff-groups can be described as a system of **network generalized reciprocity**. Group members provide benefits to specific others and expectations of reciprocating of any kind after receiving are unlikely to play a role. Considering the findings of Yamagishi & Cook (1993) [37] we argue that *give* provision is similar to network generalized exchange in so far as A gives to B, B gives to C & C gives to A. Generalized reciprocal pattern of this kind had been observed in online GES similar to Freeyourstuff-groups. For example Nelson & Rademacher (2009) [12] observed this exchange pattern on the gift exchange website Freecycle. Thereby, giving is not characterised by directly reciprocal expectations and not even to reciprocate at all. Similar to network generalized exchange, group members provide a specific good to another group member. Thus, exchange structure is likely to be advantageous for prosocial behaviour as the diffusion of responsibility is attenuated relative to group generalized exchange and contributions are framed as gifts ([38]see section 2). However, this circular description of Freeyourstuff-groups as network-generalised exchange systems is limited. In most extreme cases, individuals may engage in giving or requesting goods exclusively. From a functional perspective, online GES often serve to match individuals with intrinsic motivations to give with others who cannot participate in market activities to satisfy desires for goods [13]. Rather than in cycles, in this case goods flow from one part of the population to the other in giver-receiver relationships. Subsuming, individuals may

join the group by a desire for giving, receiving or a mixture of both. In order to assure a concrete understanding of the gift exchange game played in Freeyourstuff-groups we specify strategy space and rules. For both cities Aachen and Duisburg the same set of strategies is given. Individuals choose to either $post = (give, need, spam)$ or to respond with a complementary public comment (request a specific gift, offer a specific gift). The strategy set for posts is defined as follows:

- *Give*: Users can post a give-message with a photo of what they are giving away. Occasionally group members add information about the approximate location of the gift on display. Thus, participating in the group with a *give* is a form of prosocial behaviour as it aimed at benefiting one or multiple individuals.
- *Need*: Users can post a need-message with a description of what they are asking for. Occasionally group members are adding a reason of why they request something.
- *Spam*: Any deviation from these two types of post is defined as spam and is meant to be deleted by the admins of the group. Whereas the former can be seen as legal activities spamming represents individual activity that is misaligned with the institutional setting of the group. In this case individuals may choose to post social events, services in contrast to goods or posts linked to a financial interests.

Most of the literature discussed in the previous section analysed the contagiousness of cooperation in the context of PGG in which individuals can give cooperative and defective amounts of units [2, 30, 31, 29, 51]. In Freeyourstuff-groups defection in the form of *spam* aims at utilizing the group channel outside of its actual purpose. Spamming in online media groups has widely reported adverse effects on group activity in general [56]. Disliking group dynamics is one of the main reasons to stay passive in online communities [57]. This indicates that spamming discourages group members from participating in group activities and diminishes the utility of group membership as a useful channel to distribute and obtain information (see appendix for examples of *spam* posts). In Freeyourstuff-groups admins decide to delete *spam* post; thus effects of spamming depend on the admins engagement of removing *spam*. Subsuming, similar to PGG prosocial and anti-social behaviour is given by the strategy space.

3.2 Key Features of Social Contagiousness

Participation is voluntary for all interactions. Thus the decision time-frame is large and requires high levels of pro-activity when deciding to post a *give* or a *need*. The relevance of cooperative and prosocial heuristics present in experimental settings [50, 51] is therefore unlikely to play a role in this decision context. In Freeyourstuff-groups individuals are exposed to multiple differing messages when receiving notifications and scrolling down their browser. The framework and display of messages is likely to influence the social contagiousness of behaviour in complex environments since out-group posts can distract individuals from processing specific group messages [49]. In Freeyourstuff-groups, the moderating influence of visibility appears to be advantageous for social contagion. As shown in figure 1, Give-posts are accompanied by photos and text which makes them difficult to overlook when they appear in the Facebook browser. However, group members only see Freeyourstuff-group notifications in their browser as a default if they did not actively turn of this option. This is likely to be the case for individuals who are only interested in posting give posts in contrast to individuals who are fully or partially motivated by engaging in requesting goods. As far as the description of Freeyourstuff-groups as a system of generalized exchange is restricted the larger the proportion of givers who may be not interested in following group activity generated by other members. Another

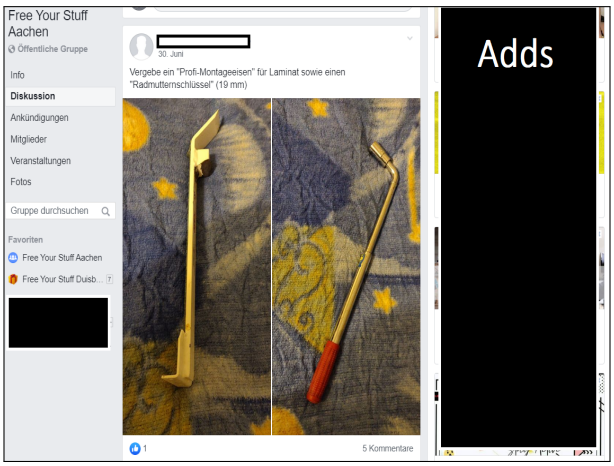

Figure 1: Display of posts in the user-interface

factor diminishing visibility of group posts may be the amount of posts unrelated to group.

Despite the display of posts also the depiction of rules is likely to influence individual participation. Facebook allows groups to be specified via group description, group category and cover picture. Descriptions specify the purpose of a group and foremost which kinds of posts are allowed and not allowed (See appendix for a summary of group specifications in both cities). These features are similar among treatment and control group with two notable exceptions: First, the group in Aachen includes a "don't be greedy" statement. Possibly, subjects may therefore be more reluctant to ask for gifts or set up requests. However, prior research may provide an indication for this to be of lesser relevance. Ariely et al. (2018) [58] investigated demand of a good under public observation and compared prices from 0 and higher. Attaching a price of 0 to goods compared to positive prices increased the number of people choosing to obtain the good but lowered the number of units taken on average to 1. Overall consumption decreased compared to attaching any positive price on the good. The authors conclude that not appearing to be greedy is a strong descriptive norm in cases when the price of a good is 0. Second, rules in Aachen are more visible as they are depicted in the cover picture of the group whereas in Duisburg a panorama picture of the city is used. Group members in Aachen may therefore be more aware about the rules compared to group members in Duisburg. Ambiguity in regard to rules is likely to have adverse effects for active participation of new members [8] (see appendice A &B for more details).

Under imperfect anonymity, *social cues* available to the giver increase prosocial behaviour in the dictator game. In Freeyourstuff-groups members encounter each other as strangers but not under anonymity as in most experimental settings. In particular, name and a small profile picture of others are visible to every group member even without leaving the group browser. Both features, name and the display of faces are relevant for increasing shares in the dictator games under laboratory conditions [54, 55]. Thus, we assume that relevant social cues are salient for group members and have an advantageous impact on social contagiousness of prosocial behaviour. Literature on gift giving highlights positive effects on willingness to give originating from perceived similarities between giver and receiver reflecting social proximity [42, 43]. As mentioned above group members may differ in their motivation to join by a desire of giving, receiving or a mixture of both. Moreover, group members are likely to differ in their motivation for *gives*. Generally *gives* are likely to be a behavioural expression motivated by differing

other regarding preferences aimed at positive self-image affirmation [5] and warm glow altruism [59]. Previous survey based studies identified acting altruistically on Kessi [8, 9] and environmental friendly on Freecycle [10] as major intrinsic motivations for gift giving in online GES. In Freeyourstuff-groups ecological rather than altruistic goals are highlighted in the group description (see appendix). The group may therefore rather attract individuals motivated by ecological factors. As examined above, the group environment favours a diverse sample of subjects who differ in their motivation to join and are likely to yield heterogeneous sets of values. Freeyourstuff members are likely to be aware of motivational heterogeneity in regard to joining and giving within the group. Nevertheless group members may perceive a distinct kind of similarity. Generally shared group membership supports empathy and helping within a group [60]. As noted, Freeyourstuff-groups are locally bounded. Sharing the same living space represents a similarity and group-membership may likewise reflect and enforce a sense of community [11] favouring prosocial behaviour due to its local roots [61]. For example Suhonen (2010) [8] et al found that increased interactions with the online GES Kessi lead to increases in perceived solidarity, trust and awareness with the local community. In return feelings of solidarity and trust enhance willingness to give [62] and request help in online communities [63, 62].Thus, engaging in both giving and requesting (instead of either giving or requesting) simultaneously becomes more likely in dependence of interaction frequency and time duration of group membership.

The group in Aachen was founded on 13.07.2016 counting 999 members at the beginning of the observation period. The control group in Duisburg was founded on 30.08 2012 counting 1423 members at the beginning of the observation period. Following Isaac, Walker & Williams (1994) [47] we assume that group size of both groups is advantageous for prosocial behaviour. Network tie-strength, ergo a felt sense of community may be more present in Freeyourstuff Duisburg as the group was founded approximately 4 years earlier (see section 8 for proxy data on tie-strength). Thus far, we conclude that exchange structure, ties, framing, presence of social cues and group size appear to be advantageous for CPS in both groups. On the other hand, the time horizon is disadvantageous for CPS. Whereas the visibility of group posts is presumably high, it is still unclear to which extend members perceive group posts.

4 Experiment & Treatment Design

In the observation period from 01.05.2019 till 01.06.2019 daily data on *give*, *need* and *spam* posts of Freeyourstuff Aachen and Duisburg were collected (see 3.1 for definitions). Growth rates were collected until the consecutive month (01.07.2019). The following will specify the design features of the gift-treatment. The treatment was processed from 01.06.2019 until 14.06.2019. Within this period 14 gives were posted using real Facebook accounts. In case a group member responded to a post, the gift was transacted to the first group member who reacted (see treatment inventory in appendices D).

Figure 2 shows the gift distribution. Thereby, each coloured vertical denotes one *give* post. Colours denote differing Facebook accounts used for the distribution (N=5). Numbers below denote the exact date of publishing. Finally A and B denote two central pick up locations in Aachen.

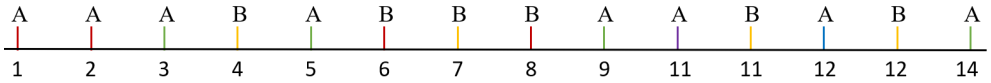

Figure 2: Treatment Timeline

The treatment was designed to optimize impact in regard to attention, avoiding suspicion, diminishing noise and reactions. Out of 14 *gives* 8 had been accepted by Freeyourstuff members in Aachen. The following motivates special design features of the treatment.

Gift-Selection: In order to avoid adverse effects on acceptance rate it seems desirable to diversify types of gift posts by avoiding to post similar types of goods. An intuition for that can be drawn from standard satiation theory. Within the group, gifts of the same type (for example household stuff) will be accepted with a decreasing probability [64]. On the other hand, new types of gifts may not be relevant for group members. Therefore, gifts were diversified based on the posting history of accepted gifts in other Freeyourstuff-groups in Heidelberg and Duisburg. Consecutively the determined gift types were compared with previous non-accepted ones in Freeyourstuff Aachen and sorted out accordingly. Thus, past accepted gifts in similar groups were used to approximate an optimal set of diversified and relevant goods for the treatment group. The treatment consists of 14 different sets of gifts each of them representing a *give* post. The range of items per *give* post differ between 1 and 5 items per post (see treatment inventory list in appendices).

Using multiple Facebook accounts: Relying on reactance theory and principles of complex contagion, accounts used for the distribution of gifts should have a credible identity and be high in numbers. We therefore use multiple accounts with true identities. Using artificial or low numbers of accounts could eventually raise suspicion about the givers identity and intention. This could induce a feeling of being manipulated causing reactance. Reactance theory describes the desire to maintain or regain own freedom when feeling pressured towards an option if the decision is expected to be free and appears relevant to the decision maker. Both is likely to be the case when deciding to post a *give*. Reactance predicts relative under-weighing of behavioural options who are perceived as being desired by a manipulative source in order to regain and maintain freedom (Clee & Wicklund, 1980) [65]. In Freeyourstuff-groups, members may question the intentions of the giver when repeatedly posting *give* or realizing that the account who is offering a gift is not credible. This may result in a lower gift acceptance rate or even undermine social contagion. Despite this, principals of complex contagion emphasize that not only frequency of exposure but also from multiple sources compared to one source predicts social contagion [66]. This is also in line with predictions of informational and peer influence [7]. During the experiment, most accounts had been used multiple times. This reflects a limitation of the treatment design resulting from a trade-off between using as much accounts as possible and using accounts based on true identities.

Post-Frequencies: The frequency of posting gifts was optimized in regard to assure a continuous saliency of the group when individuals are using Facebook. From 01.07-09.07 gifts were distributed on a daily frequency via Facebook accounts under direct control. The remaining 5 gifts were irregularly distributed (10.07-14.07) by using prior and 3 additional accounts distributed by other experimenters. Generating daily activity in the group intends to increase its saliency and may support habit formation of observing the group. By introducing new accounts and irregularities at the second stage of the treatment period the distribution pattern is meant to appear more random to group members.

Pickup locations: Individuals are assumed to consider physical distance to the pickup location as a form of transaction costs when deciding on whether to respond to a *give* post. Hence, the pickup location in interaction with social segregation may work as a selection mechanism. Therefore, two apartments on opposite sides of the city centre were selected in order to diminish response-selection effects driven by distance to pick up location (see appendices E to view the position of both locations.)

Account control & gift-transaction: 3 of the used Facebook accounts were under

direct control whereas additional 3 accounts were controlled by external experimenters. Face-to-face transactions of gifts were likewise conducted by external experimenters as well. Further, experimenters obtained instructions on how to handle transaction and communication with subjects (see appendices C).

5 Modelling Social Influences in online GES

Based on the premise of social influence mechanisms, we now model an online GES as a benefits network. Individuals can transmit marginal benefits to one another forming a pattern of cyclical cooperation leading to Pareto improvements. We build up on Elliott's & Golub's (2019) network approach to public goods a[67]. [6] The goal is to denote the interplay of social influences in a cyclical benefits network in which individuals provide benefits to each other leading to self-enforcing Pareto improvements in a specific network. The main result is that members contribute *gives* accordingly to previously received and observed *gives* mediated by their tendency to respond to upstream reciprocity and third party influence.

5.1 A model of CPS in Freeyourstuff-Groups

Consider a network in which each group member i of a set $N(1, 2, ..., n)$ can choose sequentially the number of *give* posts $a_i \in \mathbb{R}_+^{\kappa}$ (section 3.1) at any time t and creating positive externalities to $k = \sum a_i$ other group members. Let us denote member i's utility at time t as a function with concave and continuously differentiable properties $u_i^t(a) : \mathbb{R}_+^{\kappa} \to \mathbb{R}$. Further we denote time t as t_0 for the current time period and t_p for all past periods. Member i's utility depends on giving a_i, receiving $(a_{j,i})$ and observing $(a_{j,k})$ *gives* from member j. In order to distinguish between giving and receiving (observing) a we denote first giver and secondly the receiver as indices of a.

We take the following assumptions for the model. We assume that giving is costly such that $\partial u_i / \partial a_i < 0$ for any $a \in \mathbb{R}_+^{\kappa}$ and $i \in N$. Costs of a_i can be thought of as transaction costs originating from finding a disposable good, computing a post and communicating with potential receivers. Thus, we abstract from intrinsic factors of *give* posting such as warm glow altruism, environmental concern and decluttering (discussed in section 3.2) to keep focused on extrinsic social influences. For the sake of simplicity, we assume that i does not discount utility across time periods $u_i^{t_0}(\cdot) = u_i^{t_1}(\cdot)$. Now we turn to specifying is utility function at time t_0. We model social influences by integrating a vector of past received benefits into i utility function. Thereby we imply that past benefits contain relevant information for When costs c_i and benefits v of any activity a are separable from each other than:

$$u_i^{t_0}(a_i^{t_0}, a_{j,i}^{t_p}, a_{j,k}^{t_p}) = v(\alpha \sum_{j \in N} a_{j,i}^{t_p}, a_{j,k}^{t_p}) - c(a_i^{t_0}) + \Theta(\cdot)$$

In particular, i's utility is a function of posting a *give* a_i reflecting costs of transaction as described above. Secondly, member i's benefited from receiving $a_{j,i}$ from member j's chosen level of *give* posts distributed to i. According to upstream reciprocity, i is willing to give $a_i^{t_o}$ based on benefits received in the past $a_{j,i}^{t_p}$. Finally, i derives utility from observing j's chosen level $a_{j,k}$ group member $k$benefits from. According to third party influence, i will choose $a_i^{t_o}$ in dependence on observed benefits provided from j

[6] Elliott & Golub consider a network in which entities provide non-rival heterogeneous benefits to each other. They define Lindahl outcomes as the eigenvector centrality of accumulated contribution decision. The authors develop a normative model that implies institutional mechanisms to find Pareto improvements.

to k. The parameter α ($\alpha \geq 0$) denotes i's prosocial orientation e.g. compliance with prosocial norms of giving back utility received in the past at t_p(see section 5.2). Finally let $\Theta(\cdot)$ be a vector of moderators given by the environment (see section 3.2).

Given a profile of utility functions $U = (u_1, u_2, ..., u_n)$ we define a n-by-n benefits matrix $B^{t_0}_{i,j}(a; u)$ that denotes marginal net benefits among members i, j at time t. In particular we capture the marginal rate of substitution for received (observed) $a_{j,i}$ ($a_{j,k}$) and costs a_i. According to upstream reciprocity, i is willing to give $a_i^{t_0}$ based on benefits received in the past $(\partial u_i/\partial a_{j,i})^{t_p}$ and costs of giving $(\partial u_i/\partial a_i)^{t_0}$. According to third party influence, i will choose $a_i^{t_0}$ in dependence on observed benefits provided from j to k $(\partial u_j/\partial a_j, k)^{t_p}$ relative to $(\partial u_i/\partial a_i)^{t_0}$. The matrix takes the value 0 if $i = j$ stating that there will be always zeros on its diagonal and also when the above described expression would be smaller than zero. Thus, the matrix $B^{t_0}_{i,j}(a; u)$ captures the marginal rate of substitution between received benefits and giving benefits. [7]

$$B^{t_0}_{i,j}(a; u) = \begin{cases} \frac{(\partial u_i/\partial a_{j,i})^{t_p} + (\partial u_i/\partial a_{j,k})^{t_p})}{-(\partial u_i/\partial a_i)^{t_0}} & \text{if } i \neq j \; and > 0 \\ \\ 0 & \text{otherwise} \end{cases}$$

Thus we can write i's individual effort $a_i^{t_0}$ as proportional to the weighted sum of member j's contribution to any member in the past mediated by is α value.

$$a_i^{t_0} = \sum_{j \in N} (B^{t_0}_{i,j}(a) a_{j,i} + B^{t_0}_{i,j}(a) a_{j,k})$$

5.2 Behavioural Predictions

We will now use the above notation as a framework to motivate behavioural predictions driven by treatment. We focus on underlying drivers of both influences in this particular setting and clarify how they are reflected in the model. In Freeyourstuff-groups, an individual that benefited from a *give* post from another group member is expected to be more likely to post a *give* according to upstream reciprocity. We discuss changes in emotional status, mental accounting and belief system as key drivers of prosocial behaviour change according to upstream reciprocity. Emotional status (changes in $B^t_{i,j}(a_{j,i}; u_i)$): One driver of upstream reciprocity is the emotion of gratitude ([68, 69, 70, 71]). Bartlett & DeSteno (2006) found that after inducing gratitude individuals increased effort to support a benefactor and separated it from the effect of affect driven heuristics and other positive emotions. A follow up study found that gratitude drives costly prosocial behaviour even when interacting with strangers. In line with reactance theory (see treatment design), this effect attenuates when individuals learned that their gratitude drives behaviour. Further, Chang, Lin & Chen (2012) [72] found a strong relationship between having benefited in the past and empathy towards other strangers in reoccurring similar social contexts. Gratitude matters also in a group community context in the online GES Kessi. Individuals increasingly attach positive feelings of solidarity and sympathy towards the group as surveyed in the online GES Kessi [9]. Finally, the feeling of gratitude is stable even after reciprocating [71] indicating that gratitude may have long lasting effects on reciprocal behaviour.[8] Indebtedness & Obligation (changes in $B^t_{i,j}(a_{j,i}; u_i)$):

[7] This matrix is revealed to group members ex post through the sequential matching procedure. Group members obtain information about which links are beneficial and which are not.

[8] Notably, the intensity of experienced sympathy and solidarity through generalized exchange is thereby relatively high compared to other forms of beneficial good transactions such as market exchange. In a comparative field study Willer et al. (2012) [20] find that individual group sentiments within indirect exchange systems are stronger compared to direct market exchange systems.

Individuals may also feel indebted to favours received in the past and obligated to balance one's own debts by reciprocating them back to the group in the sake of complying to reciprocal norms. However feelings of indebtedness originating from social pressure are merely determined by whether they are articulated by the giver [73] which is untypically the case in online GES [12]. On the other hand, people might also experience obligation as a pressure from self-directed goals when experiencing cognitive dissonance between receiving and maintaining a positive self-image [69, 5, 74].[9]. In the model dissonance may be interpreted as an urge so substitute utility from received favours with a proportional response to give to keep the rate of receiving and giving $B^t_{i,j}(a_{j,i}; u_i)$ in balance. In an experiment run by Tsang (2007) [71] students received tickets of differing values and observed whether they would forward the favour to others. Indebtedness predicted upstream reciprocity but the effect was smaller compared to gratitude (see also [70]). Moreover, feelings of indebtedness decreased after reciprocating. We conclude, that this indicates that indebtedness does not promote upstream reciprocity if group members already posted a *give* in the past. Group members who posted a *give* in the past will likely evaluate the outcome as fair after having received a treatment *give*. Members who posted a *give* in the past may feel that they earned the gift rather than feeling that it has been allocated to them (see [75]).

Updating belief system (Changes in $\alpha_i^{t_0} > \alpha_i^{t_p}$): After receiving a *give*, recipients may also update their belief system in regard to generosity of society in general and in particular of Freeyourstuff members. Benefiting from others increases the perception of being embed in a prosocial context which increases the likelihood of acting prosocial. The treatment enforces this perception and changes the standard of appropriate behaviour by contributing to a prosocial norm. As a result, belief adaptive prosocial behaviour becomes more likely [76, 3]. For example Peysakhovich & Rand (2015) [3] report that subjects making positive experiences in prisoners dilemmas act more prosocial in dictator games. Subjects also scored higher on the world values survey measuring trust and prosocial orientation compared to those who did not experience cooperation in the prisoners dilemma.[10]

Third party influence describes norm-adaptive behaviour change based on observing a certain behaviour and a corresponding compliance with a descriptive or injunctive norms [78]. According to Deutsch and Gerard (1955) [19] a third party influence may be either informational (referring to a descriptive norm signal) or normative (referring to an injunctive norm). A descriptive norm is introduced if behaviour is observed by insignificant others such as strangers. When group members observe an increase of giving activity, *give* posts represent an informational third party influence. Whereas most group members will perceive an enforcing informational influence a sub set of group members may be befriended with the accounts used for distributing the treatment. When befriended individuals observe each other's *give* posting behaviour it may be rather defined as a peer influence. Such influence spreads via an injunctive rather than a descriptive norm signal [7]. Peer influenced *give* posting may yield some kind of social reward in contrast to third-party influence.

Third-party influences may enforce *give* posting via changes in emotional status and changes in the belief system. In case of a peer influence, group members may also be motivated by some kind of social reward. Emotional status (Changes in $B^t_{j,k}(a_{j,k}; u_i)$): When observing a generous act, individuals can experience feelings of elevation. Elevation induces a desire to act prosocial and to help others too [79]. Schnall, Roper &

[9]Cognitive dissonance: An unpleasant cognitive state caused by a contradiction of behaviour and cognition. In this context, giving back can be considered to be an attempt to solve cognitive dissonance through behaviour change. [74]

[10]prosocial orientation and prosocial offers in the one-shot dictator game and PGG are strongly correlated (see Peysakhovich, Nowak & Rand (2014)[77])

Fessler (2010) [80] induced feelings of elevation by letting subjects watch a video clip showing acts of generosity. Afterwards subjects helped the experimenter roughly twice as long with a boring task compared to subjects who watched a merely entertaining video (see also Aquino, McFerren & Laven (2011)[81]). In Freeyourstuff-groups, continuously observing increases of *give* posts may induce feelings of elevation similarly. Updating the belief system (changes in $\alpha_i^{t_0} > \alpha_i^{t_p}$): Similarly, as discussed for upstream reciprocity; group members may update their belief system based on observing other *give* posting behaviour. However, in contrast to upstream reciprocity third party influence does not necessarily have a positive effect on prosocial behaviour in dependence on the extend of observed prosocial behaviour as some experimental evidence lets suggest [7]. As the number of observed *gives* increases, own contributions may appear less essential and observing additional *gives* can have an adverse effect on posting a *give* oneself. Assuming that the treatment was constructed advantageous for CPS such that $a_i^{t_0} > a_i^{t_p}$. We hypothesize based on mechanisms of upstream reciprocity and third party influences that:

H1: Relative to the control group, the give posting activity in the treatment group will be significantly higher in the treatment period.

We now turn to developing a supplemental hypothesis. In particular we consider the role of behavioural dynamics with regard to CPS. In free your-stuff-groups members can engage in prosocial behaviour in line with rules of the group by sending *give* and *need* posts. On the contrary, group members may also act anti-social by sending *spam* posts and thereby break rules of the group (section 3.1). Those behaviours may be entangled with each other, forming a pattern of multiple contagious influences on the group channel. Therefore we integrate interacting behavioural dynamics into the analysis of CPS in Freeyourstuff-groups. In order to integrate contagious influences of *need* and *spam* posts into our analysis we extend our model by relaxing the assumption of $a_i \geq 0$. Consider a_i^t as a measure of member i's behaviour within the benefits network that increases with prosocial *gives* and *needs* but decreases with anti-social *spam* posts. Thus, a_i may also become negative.

As mentioned in section 2, differing social behaviours can relate complementary, neutral or competitive to each other forming a pattern of interacting complex contagions [27]. Here we assume that *competing* within-group dynamics of social contagion are present between *complementary* legal activity (*give* and *need* posts) on one side and illegal activity (*spam* posts) on the other. In particular, *needs* are likely to relate complementary to *gives* because they facilitate gift giving due to decreasing transaction costs $(\partial u_i/\partial a_i)^{t_0}$) ruling out the risk that the particular good is not needed compared to a *give* post. For example Althoff, Danescu & Jurafsky (2014) show the effectiveness of requests on a philanthropy website [43]. Though, *need* posts may attenuate visibility of *give* posts and corresponding norm signals [49]. Thus it is not clear how *give* and *need* relate to each other within the spectrum of complementarity.

On the other hand, spamming may discourage participating in the group. This implies an adverse dynamic of contagions between *give, need* versus *spam*. We argue that *spam* represents a form of antisocial behavior opposing *give* and *need* posting as a form of prosocial behaviour (section 3.2). We base this assumption on the reported contagion of defective and anti-social behaviour in a broad variety of social contexts [3, 29, 30, 31, 28, 24, 32, 33, 34] and the finding that competing social contagions can attenuate each other [27]. We hypothesize that:

H2: Taking behavioural dynamics of spam, need and give posts into account, prosocial behaviour in the treatment group will be higher compared to the control group.

6 Method & Variables

In order to test the central hypothesis a simple difference in differences method (two groups, two time periods) is applied. Daily data on group activity are obtained resulting in 31 observations per period (124 in total). We use robust standard errors to control for heteroscedasticity [11]. Robust standard errors are likely to underestimate true standard errors if auto-correlation is present [83]. In particular the frequency of give posts may relate to prior observations within a group. Thus, each observation contains less information compared to independent observations. Since we aggregate standard errors they are not adjusted for auto-correlation within groups but are computed as if they were dependent across groups. Though it is possible that group activity is generally higher at certain times in a month; auto-correlation of group activity is intuitively more important here. As argued by Abadie, Athey, Imbens & Wooldridge (2017), from a design perspective it would be desirable to cluster standard errors regardless of the relevance of auto-correlation because data are obtained at the group level [84]. However, standard methods to adjust bias of standard errors such as clustering and bootstrapping require larger samples and seem to perform worse for small samples with only 2 groups and time periods [85]. In fact in this particular case clustering does not produce interpretable results at all. Nevertheless, using robust standard errors is clearly a limitation for the reasons mentioned above.

We now turn to the regressions used to determine the treatment effect. Testing H_1 we run a regression with *give* as outcome variable. As described in section 3.1 the variable *give* counts the amount of *give* posts and responses offering help to *need* posts. Thereby, T_i is a binary variable $T_i = 1$ for the treatment group in Aachen and $T_i = 0$ for the control group in Duisburg. Further, t captures pre-treatment ($t = 0$) from 01.05.2019 till 31.05.2019 and treatment period ($t = 1$) from 01.06.2019 till 01.07.2019.

$$give_{i,t} = \beta T_i t + \rho T_i + \gamma t + \alpha + \epsilon_{i,t}, t = 0, 1$$

Testing H2 we add the variables *need* and *spam* to construct a coherent measure of group activity. Need counts the number of need posts per day. In contrast to the count of the variable *give* comments are not included because the interest of analysis is restricted to influence of *need* posts towards *gives* only. The variable spam, counts the number of spam post per day. Thereby only spam posts who were not deleted within an hour after they have been posted were included. The intuition for this selection is that spam posts who are deleted rapidly will not be noted by most group members. Consecutively we categorize the variables *give* and *need* as legal and *spam* as illegal activity by constructing the variable *givneespam = (give + need) – spam*. By constructing a measure that is purely additive and subtractive, we imply linear relationships between *give*, *need* and *spam*. Thus *givneespam* reflects only a theoretical approximation of the true relationship between the differing behaviours. However, this estimate is relatively conservative as literature found defection to be more contagious and robust compared to cooperative behaviour ([31, 29]). The relationship between give and need is more ambiguous. [49]. Therefore the variable *givespam = give - spam* is included into analysing H2. This way we account for dynamics of give and need on the most extreme ends between perfect complementarity and neutrality. Similar to the method for H_1 we estimate the outcome variables *givneespam* and *givespam* as follows:

[11] If data are modestly heteroscedastic robust standard errors can be more biased compared to non-robust standard errors [82] (section 8.1). However standard errors do not change substantially in this case (see appendices G)

$$givneespam_{i,t} = \beta T_i t + \rho T_i + \gamma t + \alpha + \epsilon_{i,t}, t = 0, 1$$

$$givespam_{i,t} = \beta T_i t + \rho T_i + \gamma t + \alpha + \epsilon_{i,t}, t = 0, 1$$

Further we report additional information about the Freeyourstuff-groups in Aachen and Duisburg to obtain intuitions about relevant group features such as dynamics and as individuals attributes within the population. In particular, we observe group size at the beginning and end of each experiment period and the consecutive month. This may be relevant as new members can encourage prosocial behaviour [29]. Further we obtain descriptive data on individual attributes by using a web-scrapping technique which allows to use and subsume relevant public information from group member profiles. We approximate willingness and capability to give by obtaining data on individual occupational status. In particular we define the binary variable *occupation* which takes value 1 if a group member stated on his profile to be employed or self-employed. It takes the number 0 if a group member stated that a study as current occupation. If no information are available subjects are excluded from the sample. Compared to students, working individuals may accumulate more goods to give away. It is likely that they obtain higher monthly incomes and are older resulting in longer time periods in which goods have been acquired. Compared to working subjects students act less prosocial in dictator games according to a meta analysis conducted by Engel (2010) [86]. However, the validity of the data is questionable since individuals do not necessarily update their occupational status frequently. Finally, we use the time duration of members being part of the group to approximate tie strength e.g. a felt sense of community. These data are collected from either group list from Freeyourstuff Aachen and Duisburg. Tie strength among individuals of a network increases responsiveness to social contagion [40]. We use time duration in particular because it is an established measure to predict tie strength on social media platforms[41]. In order to do so, we generate the variable *netage* as a categorical variable which lists individual membership by months.

7 Results

In this chapter we analyse descriptive information on the populations of Freeyourstuff-groups Aachen and Duisburg. Thereby we supplement the qualitative analysis on moderating factors provided in section 3. Further, we continue by reporting the main results of testing H_1 and H_2.

7.1 Descriptive Results

The selected difference in differences method requires stable groups across time periods. New members may engage in treatment unrelated *give* posting. Simultaneously old group members may feel encouraged to participate based on growth rates [29]. Therefore it is important to examine growth dynamics during the study. Table 1 shows group size of treatment (Aachen) and control (Duisburg) over time. In particular, at the end of the pre-treatment (31.05.2019), treatment (01.07.2019) and post-study period (01.08.2019). Meanwhile the group in Duisburg is larger in size, the group in Aachen grows at a slightly faster rate during the study (pre-treatment & treatment period). As the treatment group is growing at a higher rate, this may lead to an upward bias of the estimated treatment effect. Interestingly the growth rate in Aachen almost triples during the post-study period compared to the prior average. Meanwhile, group growth in the control group remains close to the average of prior periods. Speculating, this may indicate that the treatment had a positive impact on group growth.

Table 1

DYNAMICS	AACHEN	DUISBURG
Pre-Treatment	1039	1444
	(+4.04%)	(+1.45%)
Treatment	1070	1447
	(+2.98%)	(+0.02%)
Post-Study	1181	1458
	(+10.37%)	(+0.08%)

Monthly growth rates during time period in parentheses.

Table 2 shows individual data on occupation and membership duration per month sorted by group. Occupation is a binary variable that takes value 1 for studying group members and 0 for working group members. Data for occupation are based on public information provided by individuals.[12] In Duisburg (n=583; N=1447), 47,2% of the sub-sample are studying compared to 55% in Aachen (n=476; N=1070). Results of a fisher exact test confirm the difference to be significant at a 5% level (see appendices F). Following the argument made in the previous section Freeyourstuff Aachen may be less responsive to prosocial contagion due to its higher proportion of students [86]. Nevertheless, extrapolations from sub-sample to population must be treated with caution for 2 reasons. First, heterogeneous selection bias may distort the true proportions of the samples relative to each other. Secondly, the validity of the data is questionable since individuals do not necessarily update their occupational status frequently. Membership is a categorical variable that counts the duration of membership in month. Data for occupation are based on information accessible via Freeyourstuff group lists. Unsurprisingly, the difference between Duisburg (n=1388;N=1447) and Aachen (n=1043;1070) is substantial because of different founding dates. Founding group members are already 70 month part of the group compared to only 35 in Aachen. The mean group member in Duisburg is part of the group for 30 month whereas in Aachen the mean is 16 month. Running a Mann-Whitney-U-Test shows that the difference is significant at the 1%level (see appendices F). Thus, Aachen may be less responsive to social contagion compared to Duisburg based on this tie strength indicator.

Table 2

	Duisburg				Aachen			
VARIABLES	N	mean	min	max	N	mean	min	max
Occupation	583	0.472	0	1	476	0.550	0	1
Membership	1,388	30.03	1	70	1,043	16.30	1	35

N(Duisburg)=1447 N(Aachen)=1070 Note: Data were collected on 01.07.2020. Differences between variable observations and group size origin from individual privacy settings.

[12]Note:Students with a working occupation were counted as students.

7.2 Main Results

Table 3 shows the regression results for hypothesis H_1 (first column) and H_2 (second & third column). Column headlines state the outcome variables of the corresponding regression as defined in section 6. Thereby, *Treatment* is a binary variable taking value 1 for the treatment group in Aachen and 0 for the control group in Duisburg. Further, *Treatment Period* is a binary variable denoting pre- (taking value 0) and treatment period (taking value 1). Finally, the interaction term *Treatment * Time Period* captures the treatment effect. In order to test H_1 the output variable *give* is estimated. Non of the variables is significant following standard p-value requirements. Within the limitations of this study it can be concluded that there is no support for H_1 respectively; for *gives* being contagious in Freeyourstuff-groups. In order to test H_2 we construct 2 new outcome variables presuming dynamics between other behaviours. Column 2 shows that there are no significant variables including the interaction term measuring treatment impact when assuming a linear adverse dynamic between giving and spamming when need posting is assumed to relate neutral to *gives*. Column 3 shows no significant results (including the treatment impact) when legal activity (*gives* and *needs*) is presumed to relate complementary to each other and relates adverse to illegal activity (*spam* posts. Hence there is no support for H_2 based on these results and thus no support for prosocial (legal) activity being contagious in Freeyourstuff groups even when controlling for behavioural dynamics.

Table 3

VARIABLES	(H_1) $give$	(H_2) $give - spam$	(H_2) $give + need - spam$
Treatment	0.161	0.000	-0.0323
	(0.154)	(0.170)	(0.205)
Treatment Period	-0.129	-0.129	-0.0968
	(0.125)	(0.125)	(0.163)
Treatment * Time Period	0.129	0.258	0.129
	(0.202)	(0.219)	(0.266)
Constant	0.290***	0.290***	0.452***
	(0.0950)	(0.0950)	(0.112)
Observations	124	124	124
R^2	0.046	0.023	0.003

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

8 Discussion

We have seen that prosocial behaviour in the investigated gift exchange systems does not appear to be sensitive to social influences such as upstream reciprocity and third party influences. In the short run (1 month) and within the constraints of this field study giving was not contagious even when controlling for defective and complementary behavioural dynamics. This might indicate that the social structure in these online GES

is better described by Giver/Receiver types as compared to a mix of both. As pointed out in section 3.2, Givers who are exclusively interested in giving are possibly more likely to ignore group activity generated by others meanwhile Receivers are often people in need who face relatively high costs of reciprocating back to the group [13]. Notably non of the 8 group members who received a *give* by the treatment reciprocated back to the group during the treatment period. It is questionable whether results can be generalized to other online GES with different social structures along this aspect of individual behaviour. Though social influences mechanisms did not have been found here it is very well possible that other groups and regions will be more responsive. For example Wolpert (1988) shows substantial differences in community donation depending on region even after controlling for wealth and poverty differences [87]. However, it is important to point out that the constructed measures of CPS are restricted to behavioural responses who occur *within* the group since we only observe behaviour in those gift exchange systems. Membership in a Freeyourstuff group represents only a small part of multilayered individual social structures. Accordingly, behavioural responses to social influences from Freeyourstuff groups are likely to be embed in individual social structures rather than being limited to Freeyourstuff groups.

Further the results of this field study should be interpreted considering some important limitations that arise from small sample size caused by observing few groups and time periods. This implies that a potential treatment effect in order to be found needs to be relatively high such that minor effects may remain undetected. The problem of small sample size could be encountered by extending the number of treatment (control) groups and observation periods. Thereby it would be especially recommendable to increase the number of treated groups compared to adding control groups and observation periods though it would be more costly. Despite varying in regard to group size, as analysed and reasoned in section 7.1 components of social social structure (occupational status & membership duration) and thus social contagiousness differ significantly across groups. Adding treated groups could reveal how relevant in particular social structures are in regard to social contagiousness. Future field experiments operating in online GES should take into account such structural differences as additional group selection criteria. Another way of increasing experimental control for researchers could be to set up online GES themselves especially considering the influence of tie strength in relation to membership duration. Generally, increasing the sample size would also allow to obtain more accurate standard errors. Further it would allow to apply standard practices to adjust for auto-correlation such as clustering standard errors and bootstrap methods. Obtained standard errors in this study should be treated with caution because it was not possible to adjust for auto-correlation. Still they could be used as best guess in a-priory power analysis for similar experiments when calculating optimal sample sizes (given similar social structures). Due to observing only 2 time periods it was not possible to properly test the parallel trend assumption. This highlights the importance of observing more than 2 time periods per group. Whether the parallel assumption holds for this study is uncertain. Growth rates reported in section 7.1 let presume that testing for parallel trends would have been necessary to justify this assumption as higher growth rates in the treatment group had been slightly higher during the study. Moreover one sided shocks may have influenced results of the study. Considering semester breaks during the time of the study (12.07.20 till 07.10.20) the treatment group may have been relatively more affected from students leaving the city (or being occupied with exams) during that time as students represent a larger proportion compared to the control group.

Finally, a further complication arises from the treatment design itself. In particular it cannot be determined whether the distribution frequency of *gives* had been chosen optimal. As outlined in section 5.2 the treatment impact on prosocial behaviour driven

by upstream reciprocity and third party influence can be negative if adverse effects of third party influence such as the diffusion of responsibility outweigh positive impacts of gratitude, elevation, obligation and changes in belief system. This implies the following trade-off for this social intervention: On one hand, too many *gives* can reverse the treatment effect. On the other hand too few *gives* may not cause a significant upward deviation from a norm reference point (who depends on past group activity). One possible solution to this problem is to keep the amount of treatment *gives* fixed while splitting it up into multiple time periods (month). Such a design is more likely to be successful but also would have raised costs of conducting the experiment beyond the scope of this study. Remarkably an increase of group growth rates in the treatment group was observed after the study. This is potentially relevant because new members are likely to generate more activity and thus more prosocial behaviour respectively. This indicates that it is useful to observe group growth not only to discuss the assumption of parallel trends but also to evaluate indirect effects of the treatment on prosocial behaviour. Within this experimental design it was not possible to run reliable significance tests on growth rates. Future studies applying similar social interventions could integrate this aspect into analysis by increasing the number of observed growth rates.

Concluding, the study of social influence mechanisms in the field will be central to explore their relevance for human cooperation and possibilities to design context specific instruments targeting overall welfare. The development of frameworks to analyse moderators of social contagiousness is thereby a key feature because of the need to categorize and distinguish specific social structures along features of social contagiousness. Online GES (especially on social media platforms) may represent a unique and yet to be systematically explored environment providing possibilities to access a broad variety of moderating factors. Though this study finds no support for *large* effects in online GES, upstream reciprocity and third party influences may still play a general role in this social context. In online GES it is principally possible to study both influences beyond laboratory and framed field experiments, assuring that subjects do not perceive controls as unnatural. This pilot study provided insights on the variety of influential moderators in online networks and offers ways on how to improve on the design of a social intervention and measuring its impact. However, in the spirit of Harrison & List (2004) it also appears to be helpful to return to the laboratory in order to build solid theoretical and controlled backgrounds for design specifications in the field [88]. Despite modifying scope and design of potential follow up experiments in the field, creating combinations of moderating influences and testing their entangled impact on social influence mechanisms under controlled conditions in the lab will be important for the precision of future field designs. Shedding light on how moderators interact with each other is central for understanding which environmental features researchers should put an emphasis on when measuring prosocial behaviour in the field.

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Appendices

A Rules of Treatment and Control Group

Group Descriptions	
Treatment (Aachen)	Control (Duisburg)
This group is dedicated to all of us here in Aachen who tend to accumulate, accumulate and fill in spaces that could otherwise be used for something more interesting than storage and dust collector. If you have something to GIVE write that at the beginning of your message along with a description of what you are giving and the location from where it can be picked up from and if you need or want something just start your message with "NEED:". Please delete your message once something got FREE and you don't have it anymore or if you received that special something you needed. Most importantly keep it FREE! Free of money and free for all. Let's keep flea markets, competitions, sponsor-ships, job searches or apartment rentals involved for other groups. On this group people are allowed to imagine a world without money! Free of peer-to-peer advertisement as well, so don't promote any product, brand or service over another either by asking for information on it unless it's FREE.	This group is dedicated to all of us here in Duisburg who tend to accumulate, accumulate and fill in spaces that could otherwise be used for something more interesting than storage and dust collector. If you have something to GIVE write that at the beginning of your message along with a description of what you are giving and the location from where it can be picked up from and if you need or want something just start your message with "NEED:". Please delete your message once something got FREE and you don't have it anymore or if you received that special something you needed. Most importantly keep it FREE! Free of money and free for all. Let's keep flea markets, competitions, sponsor-ships, job searches or apartment rentals involved for other groups. On this group people are allowed to imagine a world without money! Free of peer-to-peer advertisement as well, so don't promote any product, brand or service over another either by asking for information on it unless it's FREE. Speciesism, like racist, sexist , discriminate or aggressive posts against anyone on this group will not be tolerated!*

Note: The table shows original group descriptions in Aachen and Duisburg. Both are available in english and german language. Differences are marked in purple. The only difference between both group descriptions is that in Duisburg a anti discrimination claim is included. We state that this difference is not relevant for experiment outcome.

B Cover Pictures of Treatment & Control Group

Figure 3: Cover Picture Aachen

Picture Caption Aachen	
Original Text	Translation
1. Alles ist komplett KOSTENLOS und OHNE Gegenleistung. 2. Ein Post beginnt mit "GIVE" oder "NEED". 3. Was abgeholt wurde, bitte sofort LÖSCHEN. 4. KEINE Beiträge doppelt posten. 5. KEINE Alben anlegen! 1 Foto, mehr Fotos in Kommentaren. 6. KEINE Infoanfragen die nichts mit Geschenken zu tun haben. 7. Tiere sind KEIN Stuff. 8. NICHTS Illegales (z.B. Drogen, Raubkopien usw.). 9. Seid nicht GIERIG.	1. EVERYTHING is completely FREE and WITHOUT reward. 2. A post starts with "GIVE" or "NEED" 3. Posts with already fetched stuff should be REMOVED. 4. NO double posting. 5. NO collections! Only one photo per post. Additional ones in the comment section only. 6. NO information requests not having anything to do with gifts. 7. Animals are NO stuff. 8. NOTHING illegal (drugs, pirated material etc.). 9. Do not be GREEDY.

Figure 4: Cover picture Duisburg

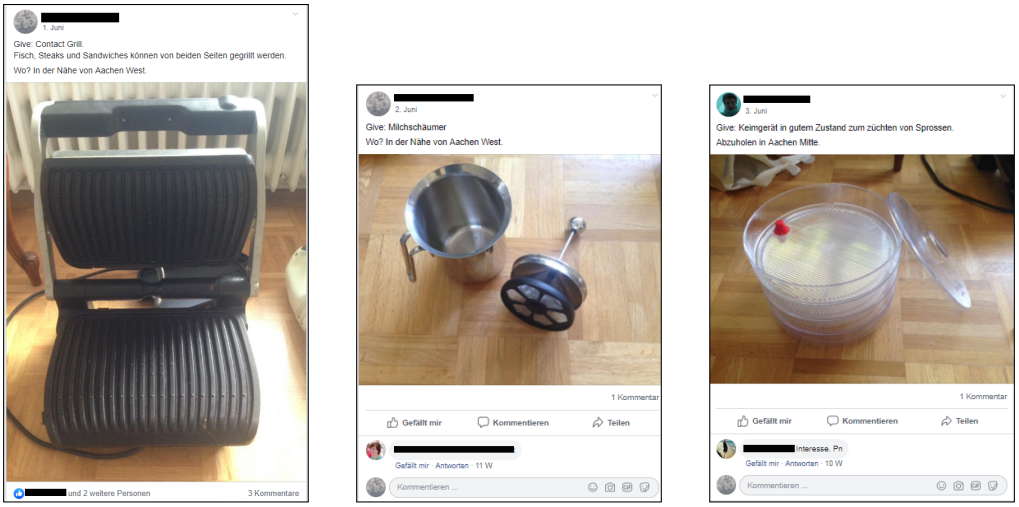
Picture Caption Duisburg	
Original Text	Translation
Free Your Stuff Duisburg - Verschenke deinen Kram und werde mit Dingen die DU brauchst beschenkt! - Kein An-/Verkauf - Kein Tausch - Keine Werbung für Neuware -	Free Your Stuff Duisburg – Give away all of your stuff and receive stuff that you need. No buys/sells – No exchange – No advertisement for new products.

Comment: First note that the cover picture "Aachen" depicts the rules of the group and repeats them in the capture. In contrast, the cover picture "Duisburg" depicts the city whereas the capture states the rules. Moreover is the formatting of the caption in Aachen better structured. Rules may therefore be slightly more visible in the treatment group. Second, Aachen includes a "Dont be greedy" clause in contrast to Duisburg. As a result group members in Aachen may be more reluctant to comment and post requests compared to Duisburg.

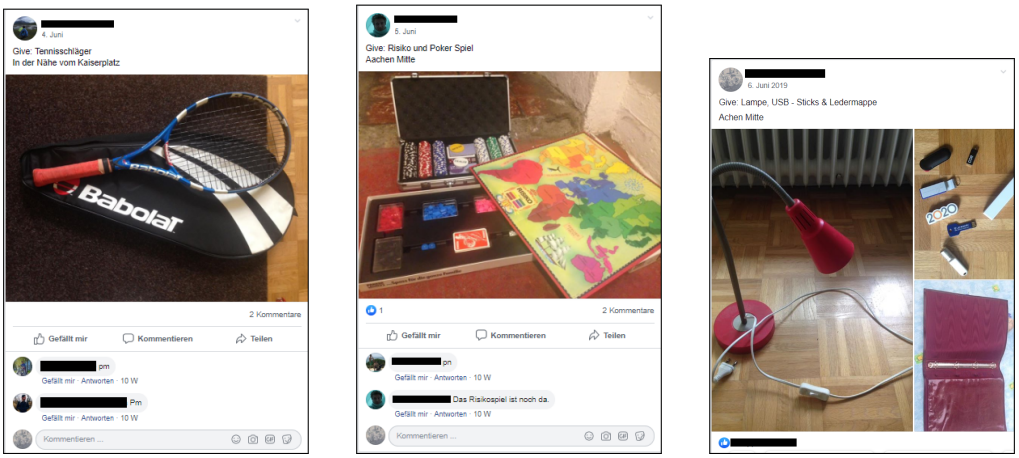
C Transaction protocol for Experimenters

- Don't tell that the gift belongs to an experiment. Instead simply say that you don't need it anymore when asked. Reason: Making subjects aware of the fact that they participate in a study may change their behaviour. They may want to help the goal of the study or otherwise feel manipulated and do not reciprocate to maintain their freedom.
- In case somebody brings a gift to you. Accept it, say thank you but communicate that its not necessary as it is not the idea of the group. Reason: The norm of reciprocity requires you to make, accept & reciprocate favours. For the purpose of this study and the group in general direct reciprocity is not the goal. By saying that it is not necessary and not the idea of the group you are pointing this out.
- Tip: Send a reminder 2 hours in advance in order to avoid complications.

D Treatment Inventory

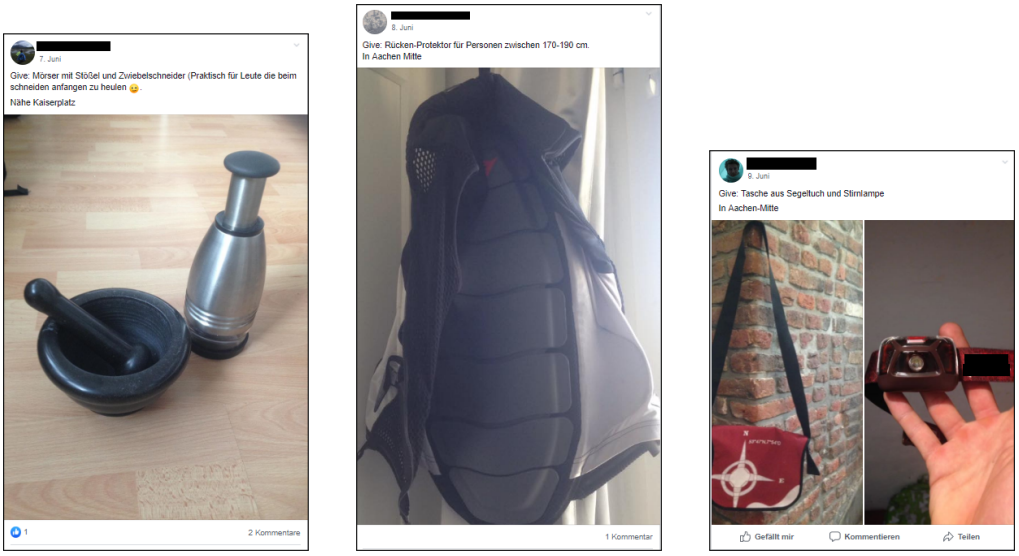


(a) From left to right: Contact-grill; milk-frother, sprouts terrace

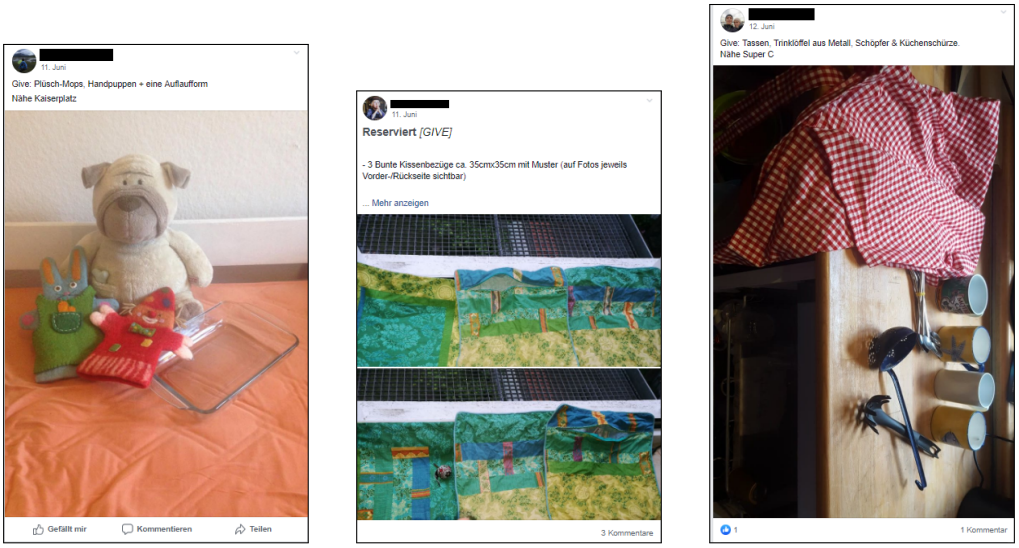


(b) From left to right: Tennis racket; Board games; Lamp

Figure 5: Distributed from 01.06 till 06.06.2019

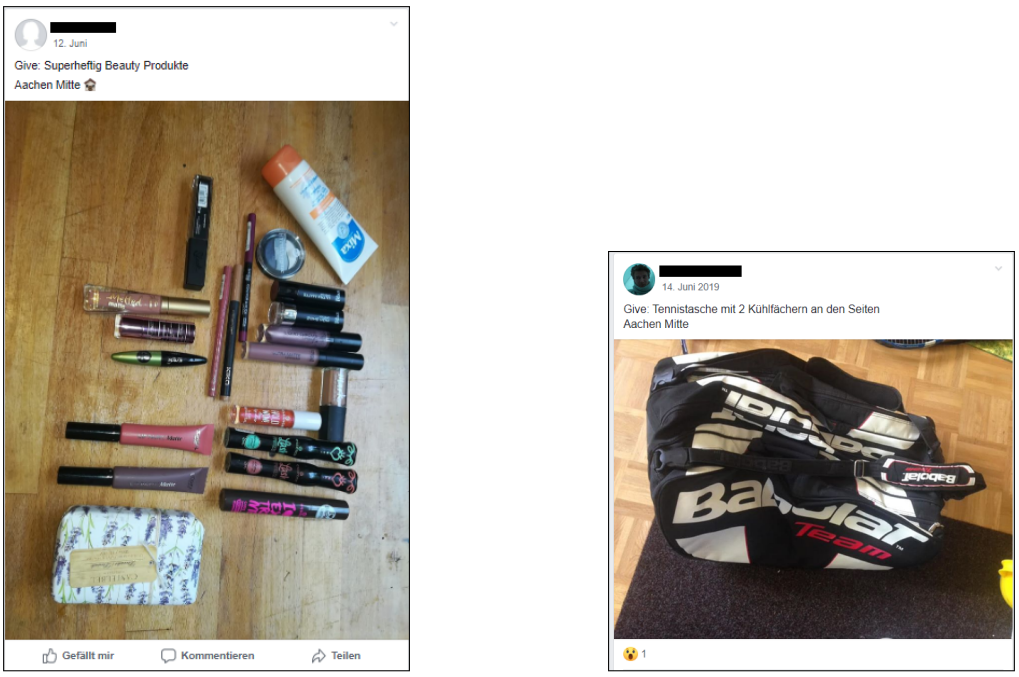


(a) From left to right: Pestle & Cocktail-mixer; Back protector, Headlamp



(b) From left to right: Cuddle toys; Pillow slips; kitchen utensils

Figure 6: Distributed from 07.06 till 12.06.2019



(a) From left to right: Make-up; Tennis bag

Figure 7: Distributed from 12.06 till 14.06.2019

E Transaction locations

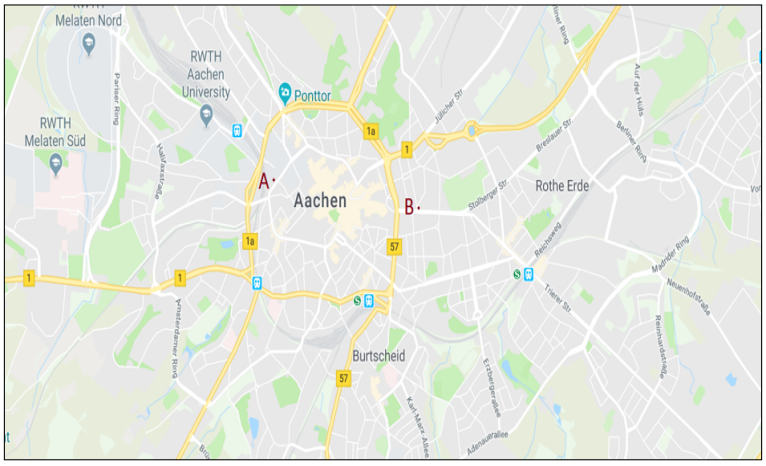


Figure 8: 1 km zoom on the city centre in Aachen

F Descriptive Results

Fishers exact Test (Table 2)

	CITY		
OCCUPATION	Control	Treatment	Total
Employed	308	214	522
Student	275	262	537
Total	583	476	1,059

Fisher's exact = 0.011 | 1-sided Fisher's exact = 0.006

Mann-Whitney Test (Table 2)

CITY	Observations	Rank Sum	Expected
Duisburg	1388	1992346.5	1687808
Aachen	1043	963749.5	1268288
Combined	2431	2956096	2956096

Unadjusted variance: 2.934e+08 | Adjustment for ties: -216870.04

Adjusted variance: 2.932e+08

H_0: netage(Duisburg) = netage(Aachen)

$z = 17.786$ $Prob > |z| = 0.0000$

G Main Results with non-robust Standard Errors

	(H_1)	(H_2)	(H_2)
VARIABLES	give	give & spam	give & spam & need
City	0.161	0.000	-0.032
	(0.143)	(0.155)	(0.188)
Time period	-0.129	-0.129	-0.097
	(0.143)	(0.155)	(0.188)
Give treatment	0.129	0.258	0.129
	(0.202)	(0.219)	(0.266)
Constant	0.290***	0.290***	0.452***
	(0.101)	(0.109)	(0.133)
Observations	124	124	124
R-squared	0.046	0.023	0.003

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1