Essays on Choices, Beliefs and Adaptive Behavior

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Abstract

This thesis consists of three essays that analyze choices and beliefs to explore how both lead to adaptive behavior. The first essay examines the positive net migration flow from the eastern to western parts of Germany. The migration decision is substantially based on expectations about future developments. With economic conditions changing substantially over the past 20 years in the eastern part of Germany, the incentives to migrate have also altered, so changing the composition of the east-to-west migrant body. This essay explores variations in economic disparities between the region of origin and region of destination, relating them to changes in the skill level, age and labor force status of the migrant population. Analyzing SOEP data from 1993-2011, the findings suggest that, with falling wage differentials, older migrants are less frequent job-to-job movers and are more likely to be non-working prior to migration. Furthermore, while migrants tend to be younger and better educated than stayers, the group of movers becomes partly less distinct from the group of stayers with respect to the skill and age composition when regional disparities in employment opportunities increase. The second and the third essay of this thesis model the decision making process in social interactions between strangers. In these situations, choices are often affected by beliefs about others behavior. In the second essay of this work, I develop a simple model of prosocial behavior for encounters between strangers. By abstracting from the possibility of reputation building and punishment between anonymous partners, I remove the main strategic motives for prosocial behavior so reducing it to a simple non-strategic decision. The principal motivation to behave prosocially is then intrinsic, based on altruism, with a taste for conforming to the behavior of others. In this way, individual decisions are conditional on the behavior of others. Emerging equilibria will then explain the occurrence of prosocial or cooperative behavior within a given society. In a second step, I analyze whether the model's predictions are consistent with the empirical evidence on the link between beliefs and prosocial behavior using data on blood donations. The third essay outline a (possible) micro-structure and conditions which lead to the observed urban-rural differences in cooperative behavior using agent-based modeling. The model presented here adapts the familiar framework of a prisoners dilemma which is played repeatedly with randomly matched members of a large population. I introduce features that are often found in real world interactions: imperfect information, voluntary participation and a taste for conforming to majority behavior. In this analysis, peoples beliefs about the level of cooperation in the population and their resulting behavior are determined endogenously. Both are governed principally by the experience that they derive from interactions. I present results of an agent-based simulation in order to study the emerging dynamic relationships, to examine how cooperative behavior evolves over time under different circumstances, and to determine how urban-rural differences in behavior emerge. The factors that give rise to rural-urban differences are heterogeneity in individual loss aversion or risk taking, and limited migration possibilities between rural and urban areas.

Keywords: internal migration, regional disparities, selectivity of migrants, prosocial behavior, generalized trust, voluntary participation, social dilemma, agent based model

Zusammenfassung

Diese Dissertation umfasst drei Aufsätzen, die sich mit Erwartungen, Entscheidungen und deren Rückwirkung auf die Umgebung beschäftigen. Der erste Aufsatz untersucht die Binnenwanderung von Ost- nach Westdeutschland. Die Wanderungsentscheidung ist wesentlich durch die Erwartungen über zukünftige Entwicklungen geprägt. Durch die deutliche Veränderung der ökonomischen Rahmenbedingungen in den letzten 20 Jahren in Ostdeutschland, haben sich die Anreize für Abwanderung und somit auch die Zusammensetzung der Gruppe der Wandernden geändert. Dieser Aufsatz nutzt Variation in ökonomischen Disparitäten zwischen der Ursprungs- und der Zielregion und setzt diese in Verbindung mit dem Bildungsniveau, Alter und Arbeitsmarktstatus der wandernden Bevölkerung. Mit Hilfe der SOEP Daten von 1993 bis 2011 gelangt die Untersuchung zu dem Ergebnis, dass mit sinkenden Einkommensdifferentialen die Wandernden weniger oft zwischen zwei Erwerbstätigkeiten wechseln, sondern zunehmend nicht erwerbstätig vor der Wanderung sind. Während die Gruppe der Wandernden im Durchschnitt jünger und besser ausgebildet als die der Bleibenden ist, verringert sich dieser Unterschied, wenn die Differentiale in den Arbeitslosenquoten zwischen den Regionen steigen. Der zweite und dritte Aufsatz dieser Arbeit widmen sich dem Entscheidungsverhalten in sozialen Interaktionen zwischen sich fremden Personen. In diesen Situationen werden Entscheidungen oft von Erwartungen darüber, wie sich andere verhalten, beeinflusst. Im zweiten Aufsatz dieser Arbeit entwickle ich ein Modell zur Untersuchung von prosozialem Verhalten in Begegnungen mit Fremden. Durch das Abstrahieren von Möglichkeiten der Reputationsbildung oder des Bestraftwerdens, entfallen die wesentlichen strategischen Motive für prosoziales Verhalten. Die Entscheidung prosozial zu Handeln ist dann nicht mehr strategisch vorteilhaft sondern intrinsisch motiviert durch Altruismus und einer Neigung sich an das Verhalten anderer anzupassen. Dadurch werden die Entscheidungen verschiedener Personen voneinander abhängig. Die entstehenden Gleichgewichte können das Auftreten von prosozialem oder kooperativem Verhalten zwischen Fremden erklären. In einem zweiten Schritt untersuche ich, ob die Erkenntnisse des Modells mit dem empirisch beobachteten Verhalten übereinstimmen. Hierzu nutze ich Blutspendedaten des Deutschen Roten Kreuz. Der dritte Aufsatz skizziert eine (mögliche) Verhaltensstruktur und notwendige Bedingungen auf Mikroebene, die zu den beobachteten Verhaltensunterschieden in prosozialem Verhalten zwischen dem ländlichen und städtischen Raum führen. Den Rahmen des hier entwickelten Modells bildet das bekannte Gefangenen Dilemma, das wiederholt mit zufällig zugeordneten Partnern einer großen Gesellschaft gespielt wird. Das Modell bezieht Merkmale ein, die sich häufig in realen Begegnungen wiederfinden: imperfekte Information, freiwillige Teilnahme und eine Neigung sich dem Verhalten anderer anzupassen. Die Erwartungen und das sich daraus ableitende Verhalten werden endogen bestimmt und basieren hauptsächlich auf der Erfahrung, die in den Begegnungen gemacht wurde. Mit Hilfe von agentenbasierter Simulation untersuche ich die entstehenden dynamischen Zusammenhänge, analysiere wie sich kooperatives Verhalten über die Zeit entwickelt und Unterschiede im Verhalten in städtischen und ländlichen Räumen entstehen. Die Modellfaktoren, die diese Unterschiede hervorrufen, sind Differenzen in der individuellen Verlustaversion und begrenzte Wanderungsmöglichkeiten zwischen städtischen und ländlichen Gebieten.

Schlagwörter: Binnenwanderung, regionale Disparitäten, Selektivität von Wandernden, prosoziales Verhalten, soziales Vertrauen, freiwillige Teilnahme, soziales Dilemma, agenten-basiertes Modell

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Contents

List of Figures

List of Tables

1 Introduction

1.1 Choices, beliefs and adaptive behavior

One characteristic of economics is its emphasis on individual choice and its interest in those factors that influences this choice. A fundamental element which shapes the way that economists view choices is the idea that individuals choose the action that will have the best consequences in accordance to their preferences. These choices are, in different contexts, at the center of this thesis. Although the underlying nature of choices is the same in regard to choosing the best alternative, they differ greatly in their characteristics: whether to migrate or to stay (Chapter 2), whether to help or to shirk (Chapter 3) or behave cooperatively or defect (Chapter 4). These choices will be taken in a constantly changing environment. Beliefs about future developments or the behavior of others are constantly updated and, in turn, actions are adjusted. Consequently, three terms will be particularly emphasized in this thesis: choices, beliefs and adaptive behavior. These interconnected terms and their relation are briefly introduced in the following.

1.1.1 Choices

Choice is closely related to decision and behavior. Making a choice leads to taking a decision and will result in behavior. Although the terms "choice", "decision" and "behavior" differ slightly in their meaning, they will be used largely as synonymous terms here.

The conventional assumption made in economic analysis is that individual choices and behavior can be explained entirely by material self-interest. Economists have performed behavioral experiments and taken observations from real life to come to the conclusion that self-interest is indeed a powerful motive in behavior. However, what can be termed 'other-regarding motives' have also be found to be important, and these include traits such as reciprocity, inequality aversion, spite or altruism. Other behavioral sciences have contributed a great deal to recent developments in economics, particularly in regard to how individual choices are affected by social influences. Yet, even if social influences are empirically relevant, it is difficult to model this behavior in a general way.

The models derived in Chapter 3 and Chapter 4 of this thesis take account of two facts that have frequently been found and confirmed in both experiments and natural settings. Firstly, that people care about how their behavior compares to that of others, and secondly, that people are heterogeneous in their preferences.

1.1.2 Beliefs

The notion of beliefs constitutes a vague term which can have many interpretations. In this work, the view taken on beliefs is as follows. An individual's belief is an endogenous outcome of the information available to her. This information is generated through her own experience, or through observations and external sources of information. In many situations, the economy does not provide a source from which the individual can receive accurate information. Beliefs therefore depend strongly on the individual's perception of the behavior of others, or upon economic prospects.

Beliefs are assumed to be of special interest in social interactions. If people only cared about their own material well-being, beliefs would play no role in social interactions. The dominant strategy would always be to shirk or defect. The considerable evidence of prosocial and cooperative behavior in situations where defection is dominant suggests that the question of preferences are more complex. This behavior has been partly explained with regard to the instance of people comparing their behavior with that of others. The individual's beliefs about the behavior of others are assumed to determine her choice, in combination with her preferences and opportunities. Choice and associated behavior influence, in turn, the future beliefs, choices and behavior of others, resulting in a dynamic relationship of choices.

A number of experimental studies have found systematic correlations between individual behavior and beliefs about the behavior of others. These correlations are interpreted as evidence of the influence of beliefs on behavior.[1] Costa-Gomes et al. (2012) and Smith (2013) were able to provide evidence for a causal relationship by using an instrumental variables approach. However, both studies find that the link between beliefs and behavior is about one third and one half smaller than the naive estimation which does not rely on instrumental variables. The implication here is that there might be omitted variables at work which influence both beliefs and choices, such as cultural influences.

[1] An alternative explanation of this correlation is one that refers to the "false consensus effect" (Ross et al. (1977)). Here, the implication is that people systematically overestimate the extent to which others follow the same behavior as theirs. Engelmann and Strobel (2000) show that the "false" consensus effect disappears when individuals receive information about the behavior of others. This means that individuals with the same information about the behavior of others do not exhibit systemically biased beliefs towards their own choice. This suggests that the effect is primarily driven by information imperfections and a tendency for behavior to cause beliefs is rather small. Yet, the consensus effect may reemerge when it becomes more difficult to retrieve information (Engelmann and Strobel (2012)).

In Chapter 3 and Chapter 4 of this thesis, choices made in social interactions are modeled. As noted above, choices often become interpersonally dependent in these situations. The underlying behavioral assumption in both models is a taste to conform to the behavior of others. Individuals look to others to decide what is acceptable, reasonable or expected within the social context in which the action is set. Consequently, choices are not purely a function of individual factors but also include the behavior of others. A large body of literature within social psychology confirms the intuition that individuals have a strong urge to adjust their behavior to that of others. Early seminal studies on conformist behavior are Sherif (1937), Deutsch and Gerard (1955) and Asch (1956). Deutsch and Gerard (1955) observed that even when the choice was anonymous and there was certainty (about the correct choice), almost one fourth of participants were still conforming to the "erroneous" choice of the others (see Luzzati (1999) p. 116). The explanation suggested by social psychologists is that individuals may suffer from "being different". The pressure to conform derives from injunctive or descriptive norms.[2] By adjusting their choice to that of others, people want to avoid the discomfort of being distinct. Many studies followed and social pressures for uniformity is a well documented property of human behavior.[3]

Cialdini and Goldstein (2004) argue that, in a given situation, individuals deduce often appropriate behavior from observing the behavior of others. This norm has come to be called a descriptive norm which can be understood as a type of social norm derived from the observed behavior of others. In this analysis, the concept of norms builds on the notion of descriptive norms. The strength of a norm is then reflected in the individual's beliefs about the behavior of others i.e. how prevalent a certain behavior is in the population. Preferences for conformity therefore cause an interdependency of choices.

1.1.3 Adaptive behavior

Environments in which individuals live, decide and act are inherently dynamic. Changing surroundings continuously influence the decisions that individuals take. Adaptive behavior of individuals is behavior that adjusts to others' behavior or situations. Through their actions, individuals in turn exert an influence on the environment. This effect is particularly strong when individual choices are affected by social influences and behavior is interpersonally dependent. It is then the interaction of individuals that shapes environments.

[2]Social psychologists distinguish two types of norms. There are norms which inform individuals about what kind of behavior is typically approved and disapproved - those are injunctive norms (Cialdini and Goldstein (2004); Schultz et al. (2007)). A descriptive norm reflects what is commonly done in a particular situation.

[3]For a review of the social psychology literature related to conformity see Aronson et al. (2010) (chapter 8) and Luzzati (1999).

The economic analyses performed in this work include a time dimension and so integrate the changes that occur over time. For each period - which can be any time unit (e.g. day or a year) - new information about economic conditions (Chapter 2) or the behavior of others (chapters 3 and 4), amongst other information, are generated and so influence the decisions that individuals need to take. They adapt their behavior to those perceived changes. Chapter 2 analyzes how individuals' migration decision is influenced by changes in the economic environment. The migration decision is substantially based on expectations about future developments. Here, the economic environment reflects the economic prospects perceived by individuals both in the home and in potential host regions. In Chapter 3 and 4, I model and analyze a dynamic environment in a game theoretic setting in which beliefs of each individual depend on the action of all. Being that beliefs influence actions, choices become interdependent with this interdependency causing constant feedback effects.

1.2 Outline of the thesis

1.2.1 Economic disparities and the composition of the migrant population

Chapter 2 focuses on the decision to migrate. Individuals decide whether it is favorable for them to migrate by comparing the difference in costs and returns which arise as a consequence of migration. This utility-centered framework predicts that an individual will migrate if the present value of utility gains from returns to migration will outweigh the utility loss from the costs of migration. The returns may include an increase in labor income, a more satisfying labor force status or higher employment probabilities. The costs of migration are the monetary costs of geographic mobility as well as the psychological costs that arise when leaving familiar surroundings. Much of these costs and gains are unknown to the individuals. The choice of migration therefore depends on individuals' beliefs about how future developments influence the returns on migration. Two main indicators of those developments are unemployment and wage differentials between the origin and destination region.

Costs and gains from migration are not randomly distributed but depend on various socio-economic factors such as age, education and labor force status. It is important to be clear that economic factors are not merely determining trends of aggregate migration but also influence the composition of the migration body because they determine the characteristics of people for whom it is beneficial to move. In this chapter, I analyze how economic disparities drive the composition of the migrant body. More precisely, how regional economic disparities in wage and employment opportunities affect not only the composition of the migrant body with respect to skills but also age and labor force status of migrants. Aside from knowing how many people migrate, it is essential to know

who is migrating. The key characteristics of migrants - i.e. attributes like age and the skills and characteristics of human capital are of special interest because they influence labor markets and the fiscal balance in the region of origin as well as that of destination. To understand the forces which are driving the composition of the migrant population is crucial in order to identify the economic and social consequences of migration.

1.2.2 Generalized trust and prosocial behavior

This chapter and the following deal with choices in social interactions between strangers. In large, modern societies, numerous interactions take place among unrelated individuals who interact only once and will most probably not meet again. At the same time, the possibility of formal contract is often limited, too onerous or too costly. The classical economic models are based on this very assumption - that individuals maximize material payoffs - and so often fail to predict behavior arising in these kind of situations. One important type of behavior that those models often cannot explain is prosocial behavior; that is, an action that mainly benefits others at a cost to oneself.

There is considerable empirical evidence from lab and field experiments that people frequently engage in prosocial behavior even when interacting in anonymous environments. The occurrence of substantial rates of cooperation and assisting of others has led researchers to question the fundamental assumptions of economic analysis. A variety of other influences have subsequently been identified, those unrelated to the payoffs associated with behaviors. A substantial number of people exhibit other-regarding preferences, meaning that they also care about the material payoffs of relevant other individuals (Fehr and Fischbacher (2002)). Andreoni and Miller (2002) test whether the utility maximization assumption still holds empirically. They find that, under the assumption of varying degrees of other-regarding preferences, 98 % of subjects act to maximize utility.

When social interactions take place between strangers, generalized trust also proves to be an important determinant of behavior. The generalized trust explored in this thesis refers to positive expectations about the behavior of others. This kind of trust denotes the feeling that a person has about the behavior of other people whom she has not personally known. The concept of generalized trust is to be distinguished from particularized trust. The latter refers to trust between people who know each other and are hence able to base their beliefs about the other's behavior when experiencing face-to-face interactions or acquiring information via third parties. Generalized trust is the extension of interpersonal trust to people who the trusting individual does not know and in regard to them has no direct information.

In Chapter 3, I relate both other-regarding preferences and generalized trust to prosocial behavior. I first develop a simple model that builds on the premise that individuals

exhibit heterogeneous degrees of altruistic preferences and care about how their behavior compares to that of others. I assume that individuals have a taste for conforming to the behavior of others in order to avoid the discomfort of being different from others (Asch (1956)). Heterogeneity in behavior may be caused by both heterogeneous preferences and heterogeneous beliefs. In a second step, I analyze whether the model's predictions of the link between beliefs and prosocial behavior can be found in real world observations. In view of data limitations, the empirical analysis is not conducted at the individual level but at an aggregate (state) level. In regard to data on blood donations in Germany, I analyze how the number of first-time-donors and the number of donations by repeat donors change with varying levels of trust and with the perceived benefits of blood donations amongst the population.

1.2.3 Choices, beliefs and trust dynamics

Chapter 4 focus on interactions between strangers in social dilemma situations. For decades, social dilemmas have been a fascinating topic of research for scholars from a wide range of disciplines. Fundamental to social dilemmas is the conflict between the behavior that is good in the short run for the individual actor and the kind of behavior that is beneficial for the society or a group in the long run. The prisoner's dilemma illustrates this problem in a simple and clear way. Interactions often occur between unrelated individuals who cannot rely on either past behavior or future interactions to establish mutual cooperation. Classical game theory analysis predicts mutual non-cooperation under a given incentive structure. However, this conclusion is challenged both by empirical studies and observations coming from everyday life. The rate of cooperation in economic laboratory experiments is commonly between 40 and 60 % in one-shot prisoner's dilemma games (Fehr and Fischbacher (2002)). Many hypothesis have been presented on why people choose to cooperate regardless. Theoretical contributions suggest multiple forms of other-regarding preferences which enable the prisoner's dilemma game to be transformed into a game with multiple equilibria.[4]

Chapter 4 draws upon the afore-mentioned literature on prisoner dilemma situations. In this case, a simultaneous prisoner's dilemma game has been developed which is build on the premise that people are motivated by their own payoff and by how their action compares to that of others. In addition, individuals have the option not to play; they choose whether or not to participate in a prisoner's dilemma. This chapter uses agent-based simulation to investigate the individual and collective behavior of a large number of agents who repeatedly engage in strategic interactions. Being that interactions are one-shot, individuals have no other possibility than to infer the other's behavior from their experience. The focus is on the implications of voluntary participation for the level

[4] See Ellingsen et al. (2012) for examples.

of trust and cooperation in the population. A further emphasis is then placed on urban-rural differences in trust and behavior as a consequence of the sorting of individuals.

2 Economic disparities and the composition of the migrant population: Evidence from East-West German migration

Abstract

For the past 20 years, there has been a persistent positive net migration flow from the eastern part of Germany to the western part. As economic conditions changed substantially during this time, the incentives to migrate have altered too and thus have changed the composition of the east-to-west migrant body. This paper exploits variations in economic disparities between origin and destination region and relates them to changes in the skill level, age and labor force status of the migrant population. Analyzing SOEP data from 1993 to 2011, the findings suggest that with falling wage differentials older migrants are less often job-to-job mover but are more often non-working prior to migration. Further, while migrants tend to be younger and more educated than stayers, the group of movers becomes partly less distinct from the group of stayers with respect to the skill and age composition when regional disparities in employment opportunities increase.

JEL: J60 J61 R23
Keywords: Internal migration, regional disparities, selectivity of migrants

[0]I would like to thank Bengt-Arne Wickström for useful suggestions as well as Nannette Swed, Jan Hansen, Thomas Siedler and the participants of the 8th International Young Scholar Socio-Economic Panel Symposium (SOEP) 2012 for valuable comments on an earlier version of this paper.

2.1 Introduction

There is little doubt that economic disparities determine migration patterns. A vast number of studies from Europe suggest that regional differences in wages and employment opportunities are important determinants of migration flows (e.g. Decressin and Fatas (1995); Gros (1996); McCormick (1997)).[1] Both unemployment and wage differentials influence gains from migration and thereby determine aggregate migration flows between regions. Within the economic literature, it is often stressed that migration is a selective process. Costs and gains from migration are not randomly distributed but depend on various socio-economic factors like age, education and labor force status. This makes clear that economic factors are not merely determining trends of aggregate migration but they also influence the composition of the migration body as they determine the characteristics of people for whom it is beneficial to move. Yet little is known empirically about the role of economic disparities in determining the composition of the migrant population.[2]

In this paper, I analyze how economic disparities drive the composition of the migrant body. Besides knowing how many people emigrate, it is essential to know who is leaving. The characteristics of migrants - i.e., their attributes like age, human capital characteristics and capabilities - influence labor markets and the fiscal balance in the region of origin as well as destination and are therefore of special interest. To understand the forces which are driving the composition of the migrant population is crucial in order to identify the economic and social consequences of migration.

To tackle this question, I use individual level data of east-to-west movers and stayers in Germany and combine this information with data on economic characteristics of the region of origin and destination. The reunification of the East and West Germany in 1990 offers a unique opportunity to study migration as it allowed unrestricted migration between two economically different labor markets with disparities still existing today. For the past 20 years, there has been a persistent albeit variable migration flow from eastern to western German states with about 3.85 million registered migration cases between 1991 and 2011[3]. At the same time, wage and unemployment differentials changed greatly between the two regions. While wages converged to a certain extent, unemployment rates still vary greatly between some states. Figure 2.2 shows how unemployment

[1] Evidence from the US shows that, besides economic factors, non-economic factors such as natural amenities are a key driver of migration flows (e.g. Ferguson et al. (2007); Chen and Rosenthal (2008)).

[2] Exemptions are Borjas et al. (1992); Arntz (2010); Arntz et al. (2011).

[3] For the sake of simplicity and clarity, this paper refers to former East and West German states as eastern and western respectively. Berlin is treated as eastern Germany here. Data source: Federal Statistical Office of Germany.

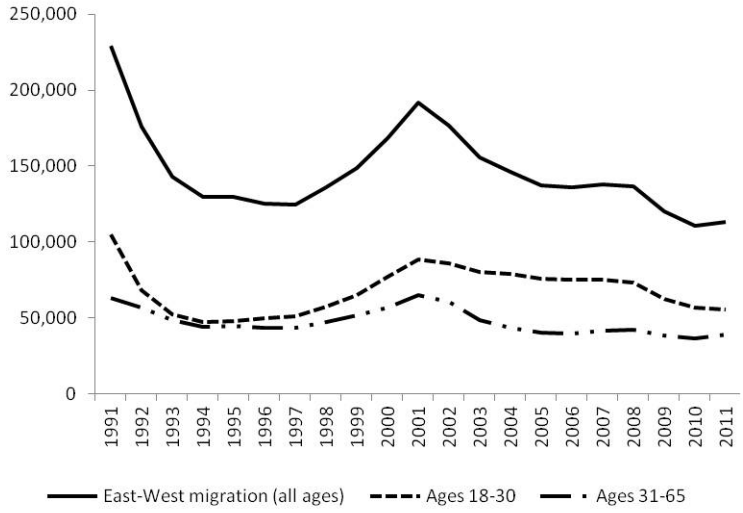

Figure 2.1: Number of people who migrated between eastern and western German states excluding Berlin (annual data). *Data source*: Federal Statistical Office of Germany.

and wage differentials (both measured in ratios) changed over time[4]. Hence, studying migration between eastern and western German states makes possible observations of a relatively high number of migrants in a range of different economic conditions. In addition, migration is in general more likely to be long-distance than migration between states. Compared to short-distance migration, long-distance migration is more likely to be driven by economic factors (Faini et al. (1997); Nivalainen (2004); Biagi et al. (2011)).

There is a large body of empirical literature investigating migrants who moved from eastern to western Germany after reunification. Most of the studies focus on migration flows in the nineties (for example Hunt (2000); Burda and Hunt (2001); Hunt (2006); Zaiceva (2006); Brücker and Trübswetter (2007)), some more recent studies also examine a longer time period (Fuchs-Schündeln and Schündeln (2009); Rainer and Siedler (2009); Siepe and Smolny (2011)). Many of them have a particular interest in the analysis of the determinants of migration, largely focusing on individual and regional factors that seem to drive the decision to move. The findings differ considerably depending on how the migration decision is modeled and how the sample is selected, but also on which time span is analyzed. The latter is of importance as economic conditions are constantly changing, causing the composition of the migrant population to vary greatly over time. However, existing studies do not adequately allow for changing characteristics of migrants

[4]The development of average wages and unemployment rates over time in eastern and western Germany is depicted in Figures 2.3 and 2.4 in Appendix A.

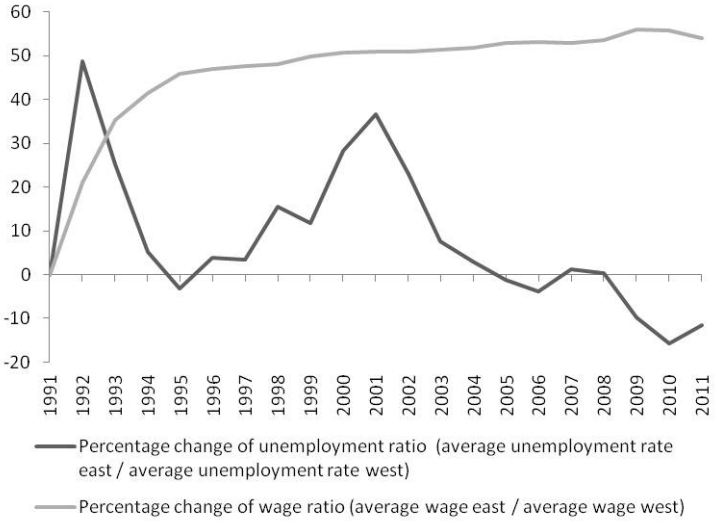

Figure 2.2: Percentage change of the unemployment rate ratio and the wage ratio from 1991 to 2011 with base year 1991 (annual data) excluding Berlin. *Data source*: Own calculation based on data from the Federal Statistical Office of Germany.

over time in their models. An exception is Fuchs-Schündeln and Schündeln (2009), who distinguish between two waves of migration in their study. The two contributions which are most closely related to this paper are Arntz (2010) and Arntz et al. (2011). Arntz (2010) analyzes how economic disparities in wage and employment opportunities affect the skill composition of the migrant population by looking at destination choices of migrants. She finds that while highly educated migrants prefer to move to regions with higher wages, comparatively less educated migrants choose regions with higher job opportunities than in their region of origin. Regarding the labor force status, the findings of Arntz (2010) suggest that the destination wage level is a stronger determinant of the migration destination for job-to-job movers than for job movers after unemployment. Arntz et al. (2011) analyze how differences in mean wages and mean employment as well as their dispersion determine the skill composition of migration flows between regions. Exploiting changing differentials between regions over time only, the authors find that the average skill level (measured in predicted wages) increases with higher differences in mean employment and employment dispersion. Both studies analyze migration flows between all labor market regions in Germany and restrict their sample mainly to the working population.[5]

[5]Both studies use the employment register data (BeH) of the German Employment Agency which contains information on individuals working in jobs which are subject to social security payments and hence excludes individuals who did not enter the labor force yet, who temporarily left the labor force or who are unemployed and do not receive unemployment benefits. Both studies restrict their

This paper analyzes the varying composition of the migrant body in a more comprehensive way. It contributes to the question of how regional economic disparities in wage and employment opportunities affect not only the composition of the migrant body with respect to skills but also age and labor force status of migrants. In addition, the sample is not restricted to the working population but is instead a representative sample of the German population. The analysis combines individual level data from the German Socio-Economic Panel Study (SOEP) from 1993 to 2011 and regional-level economic data. The number of identified migrations is relatively small and I focus, therefore, on east-to-west migration. The results show that migrants are on average younger and have a skill advantage over stayers. Yet this skill advantage is partly less pronounced when unemployment differentials between regions are high. This suggests that in times when pull and push factors of employment opportunities are comparatively weak, people with higher educational attainment and thus more particular career opportunities are more likely to move, while it is favorable to move for a broader group of people with respect to years of education in times of strong pull and push factors. The majority of migrants are job-to-job movers. However, with decreasing income differentials and hence decreasing potential wage gains, migrants older than 30 years of age are increasingly often not working but non-working prior to migration. In general, regional disparities determine more significantly the composition of the migrant body of individuals older than 30 than the migrant body of younger individuals. Yet, it is true for both age groups that the group of migrants becomes less distinct from the non-migrating population with respect to the analyzed characteristics when regional disparities increase.

The rest of the paper is organized as follows. The next section collects general evidence on east-to-west migration flows from aggregate data of previous studies. In the subsequent Section, I present some thoughts on the theory of migration. The empirical estimation strategy is outlined at the end of this Section. In Section 4, I introduce the data set and some descriptive statistics. The estimation results are shown in Section 5. The paper ends with some concluding remarks.

2.2 General evidence on German east-to-west migration trends

When the unification of the German Democratic Republic and the Federal Republic of Germany took place in 1990, the eastern German economy was in a desolate state. As a consequence, the migration flows from the eastern to the western part of Germany were substantial and significantly exceeded migration flows going the other way in the years that followed reunification. With 3.85 million total registered migration cases from eastern to western Germany between 1991 and 2011, east-to-west migration is clearly

sample to males: Arntz (2010) to males aged 25 to 45 and Arntz et al. (2011) to males aged 16 to 65. In Arntz et al. (2011) a move between regions is only identified if a person is observed to be working before and after migration.

an important phenomenon of inter regional mobility in Germany and continues to be a policy issue for eastern German states. Figure 2.1 depicts the gross migration flow of east-to-west migration from 1991 to 2011 showing the different waves of migration. The first wave was initiated with the fall of the Wall in 1989. The high yearly migration rate of the first years after reunification quickly decreased to about 130,000 migrants per year in 1994 and remained at this relatively low level for the following years. Beginning in 1998, the number of migrants rose again sharply to a peak of 192,000 migrants per year in 2001 and returned to a relatively low level in 2004 where it remained until 2010 with an average of 138,000 migrants per year. It is clear from Figure 2.1 that the majority of migrants are aged 18 to 30 years.

It has been widely observed that economic push and pull factors are important determinants of internal migration flows. Hunt (2006) analyzes determinants of east-to-west migration in Germany. Using state-level data from 1991 to 2000, she finds that the decline in east-west migration in the early 1990s can predominantly be explained by declining wage differentials. The fast east-west wage convergence of 1990 to 1994 was therefore able to reduce migration rates despite rising unemployment. She finds that the young, who make up the majority of the migrant body, are especially sensitive to wages. Alecke et al. (2010) use state-level data from 1991 to 2006 and confirm findings of Hunt (2006) for migration flows throughout the mid-1990s. For later periods, they find that this relationship becomes less stable and differences in unemployment levels become more important. They explain this finding with with an account of the gradual fading out of east-west transfers and more realistic expectations about the future convergence of wages and labor market disparities.

Similar results are found when looking generally at internal migration in Germany. Wage and unemployment differentials are especially important driving forces of internal migration in Germany (see Alecke et al. (2010) for a more comprehensive review of literature). Arntz et al. (2011) show that employment differentials have a stronger impact on internal migration in Germany than wage differentials. Although the first years after reunification seem to be different in terms of migration behavior, the determinants of east-to-west migration are not very different from internal migration in Germany in general. To avoid the distortion of results by the fast politically-driven wage convergence, I do not use observations on migration during the first years after reunification but restrict the analysis to the period of 1993 to 2011.

2.3 Theoretical framework

The theoretical framework that guides my empirical analysis is a simple utility model of migration. Individuals decide whether it is favorable for them to migrate by comparing the difference in costs and returns which arise as a consequence of migration. The frame-

work predicts that an individual will migrate if the present value of utility gains from returns to migration will outweigh the utility loss from costs of migration. The returns may include an increase in labor income, a more satisfying labor force status or higher employment probabilities. Costs of migration comprise monetary costs of geographic mobility as well as psychological costs that arise when leaving familiar surroundings.[6]

The question of who is more likely to migrate has been widely analyzed. The primary focus of my analysis is how the composition of migrants changes with respect to age, level of education and labor force status when economic disparities between origin and destination region change. Both monetary as well as psychological costs are fairly constant over time given the individual characteristics of migrants, so changes in the composition of the migrant body must be mostly driven by variations in the gains of migration. In my analysis, I focus on wage and unemployment differentials as they are the most fundamental determinants of gains from migration besides individual characteristics (Pissarides and McMaster (1990)).[7] As such, wage differentials approximate possible wage gains through migration, while regional unemployment differentials correspond approximately to differences in employment probabilities between regions.

When looking generally at the decision to migrate, individuals are likely to move when their migration cost is low and/or they receive high returns to migration. In this respect, age is clearly negatively related to the probability to move. The more years an individual continues to stay in the labor force, the higher is the cumulative wage gain through migration relative to the costs of moving. This wage gain can be due to differences in average wage levels between regions or better job matches through migration. In addition, it is less costly for younger individuals to move as they have less firm- and location-specific human capital and thus, are less tied to a certain location. Human capital is often assumed to promote the ability to move as migration costs and human capital are likely to be negatively related (Chiswick (2000); Arntz (2010)). It is argued that mobility costs may be lower for better educated individuals as they are, for instance, more efficient in gathering information. Bauernschuster et al. (2012) find that highly educated people are also less affected by psychological cost as they are more able or inclined to deal with cultural differences. Another argument for higher mobility is that individuals with a higher level of education often have very particular career opportunities and moving might promote better job matches (Nivalainen (2004)) and thus increase gains from migration. Another aspect that might drive the group of

[6] The cost side will not be treated very thoroughly in this analysis for reasons mentioned below. For analysis of east-to-west migration incorporating a comprehensive set of individual level cost indicators including psychological and social factors, see Fuchs-Schündeln and Schündeln (2009) and Rainer and Siedler (2009).

[7] Borjas (1987) showed in his seminal paper that differences in wage dispersion is also influencing gains of migration. In the German context, Brücker and Trübswetter (2007) analyzed how increasing wage dispersion in eastern Germany influences the composition of the east-to-west migrant population with respect to unobserved characteristics that are correlated with earnings. They do not find any significant effect.

migrants to be more educated is the lower importance of informal channels in finding a job. Finding a job through friends, relatives or neighbors is an important source for new jobs especially for low-skill jobs and less educated workers (Granovetter (1995)). This makes the potential labor market more localized for this group than for higher educated individuals. Being unemployed reflects relatively low opportunity costs of migration, hence, it is expected to be positively related to migration. The same holds true for individuals who are non-working or in training and who want to (re)enter the labor force.

When looking at how unemployment and wage differentials can influence the gains from migration, we need to consider both wage gains through differences in average wage levels between regions and through better job matches. When wage differentials are low, wage gains through differences in average wage levels are small and moving tends to be only favorable when migration allows better job matches that would not be possible in the origin region. This suggests that migration is only favorable for individuals with very particular career opportunities who tend to be highly educated. Decreasing wage differentials could therefore cause the migrating population to exhibit higher skills on average. The composition with respect to labor force status is likely to change too. As on-the-job searchers tend to have a higher reservation wage, a convergence of wages is likely to reduce the share of job-to-job movers and increase the share of unemployed job-movers. This might also hold true for people entering the labor force, who are either non-working or in education prior to their move. As cumulative wage gains are smaller for older individuals, a decrease of wage differentials will make migration less favorable for older individuals holding everything else constant. Diminishing wage differentials are therefore expected to decrease the average age of the migrating population.

Considering differences in unemployment levels, a first intuitive hypothesis is that strong differences in labor market tightness may lead the migrant body to be less distinct from the staying population. Given a certain unemployment level in the region of origin, increasing unemployment differentials might make it more favorable not only for highly educated or younger individuals, but for a more heterogeneous group of people to migrate, as it allows for higher employment opportunities outside their region of origin for a wider variety of people. Therefore, I assume that an increase in relative job opportunities increases the heterogeneity with respect to educational attainment and age. The same might hold true for labor force status.

2.4 Estimation strategy

I analyze how the composition of the migrant population varies with economic disparities, i.e., whether there is an interaction effect between characteristics of migrants and regional disparities. The composition of the migrant population can change (i) as a response

to changes in economic incentives and (ii) due to changes in the composition of the population living in the region of origin. Both changes are not necessarily independent of each other. The unemployment rate, for instance, is directly linked to the share of people working, being unemployed, and non-working in the region of origin, while it is also indirectly linked to the composition of the migrant population or the composition with respect to age and the level of education by inducing regional mobility for certain groups. It is therefore necessary to distinguish the effect of changes in the composition of the migrant body, which results from changes in the population of the region of origin, from the effect of changes in the composition that result from changes in incentives to move. I seek to separate both effects by using an interaction model.

Equation 2.1 shows the estimated model. The dependent variable y_{mst} is the group average of one of the characteristics which are object of the study. This encompasses average years of education, wage and age and share of individuals with a certain labor force status. Therefore, the index mst denotes the distinction between the group of movers (who live in western Germany in the subsequent wave) and stayers (who will live in eastern Germany in the subsequent wave) in different states (s) for different years (t). For each characteristic a separate model is estimated. Coefficients are determined by ordinary least squares regression. The dummy variable m indicates whether the average group value belongs to the group of stayers or the group of movers. In addition, the estimated model includes interaction terms ($m \times a_{st}$ and $m \times b_{st}$) of the mover dummy and two variables measuring wage and unemployment differentials. The mover dummy and interaction terms are of special interest as they show how characteristics of migrants change with changing economic variables.

$$\begin{aligned} y_{mst} = \beta_0 + \beta_1 m + \beta_2 a_{st} + \beta_3 b_{st} + \beta_{12} m \times a_{st} + \beta_{13} m \times b_{st} \\ + \beta_4 u_{st} + \beta_5 v_{st-1} + \beta_6 w_s + \epsilon_{mst} \end{aligned} \tag{2.1}$$

The estimated model also includes a set of control variables. As economic variables change the composition of the population living in eastern Germany through internal migration between all states (not only east to west), there are possible feedback effects of the economic variables on future values of the dependent variable. Therefore, v_{st-1} comprehends lagged values of the regional average wage and unemployment rate to account for these feedback effects of migration. However, the composition of the population changes only partly due to migration. As I analyze a relatively long time span, there are likely to be gradual shifts in labor force participation, age, wage structure and educational level that changed through demographic, cultural and institutional trends. This can be caused for instance by the aging of the population, changes in early retirement, expansion of child care facilities or rising school enrollment. If those shifts differ by state, error terms are likely to be correlated over time. Therefore, u_{st} is a set

of contemporary economic variables. Besides the unemployment rate and average wage, the general labor force participation rate measured at the state level is included for the estimations regarding the labor force status. To capture trends in wages that vary by state, I include state-level GDP. And for changes in average years of education and age, I include the number of students enrolled in a state. w_s is a set of state fixed effects.

Evidence suggests that different age groups and gender have not only a different probability to move but also differ in their migration behavior. Fuchs-Schündeln and Schündeln (2009) find that single women are more likely to move than single men and that a higher educational attainment increases the probability to move for men but not for women. Further, Hunt (2006) shows that younger migrants are much more sensitive to wage differentials than older migrants and relatively insensitive to the unemployment rate in the region of origin. Older migrants, on the other hand, are more sensitive to unemployment in the region of origin but less sensitive to income differentials. Unfortunately, the sample is too small to be split by age group and gender at the same time. As the differences in migration behavior between age groups seem more relevant in the context of this study, I conduct separate analyses for two different age groups.

2.5 Variables and descriptive statistics

For the analysis, I employ the German Socio-Economic Panel Study (SOEP) of the German Institute of Economic Research (DIW Berlin), which is a rich, annual household panel survey in Germany. The panel structure allows one to follow individuals over time and identify east-to-west migrants before migration. I use the individual-level data to compute group averages of different characteristics for movers and stayers. I combine this data with macroeconomic state-level data from the Federal Statistical Office of Germany. Table 2.1 gives an overview of the variables used and their respective definition. Variables are selected on theoretical grounds and evidence from earlier studies on migration behavior. All group characteristics refer to the current year. Hence, for movers, they refer to the observation before moving. The only exception is years of schooling. As the survey interviews are taken in spring and graduation from university and the end of vocational trainings or apprenticeships are often in summer, the observation in the year following migration is likely to be a more accurate description of the level of educational attainment at the time of migration.[8]

Data for average wages and wage differentials are taken from the regional accounts. To measure the average wage in a state, I use data on the sum of the yearly compensation of all employees divided by the number of employees. I use regional price indices to deflate wages. The average wage then only roughly approximates the difference in wages

[8]This approach is also used among others by Hunt (2006) and Fuchs-Schündeln and Schündeln (2009).

that one will receive for an equivalent job and rather shows how much a person working in that region will earn on average. Hence, the difference is not only due to differences in hourly wages, but also reflects structural differences in employment (hours worked) and industry. The values for unemployment rates are official statistics from the Federal Employment Agency, which measure the number of unemployed persons as a percentage of the total civil-sector work force.

To measure unemployment and wage differentials, I use the difference between the respective eastern (mean of state of residence) and the western (mean of all western states) value. The differentials could also be measured by the ratio of regional values. There is no clear consensus on whether differences are more relevant than ratios. The main difference between the two measures seems to be the response to the level of unemployment and wages respectively (Pissarides and McMaster (1990)). With rising unemployment (wage) levels, the ratio tends to decrease towards unity whereas the difference tends to rise. I use differences as they explain migration behavior better in this analysis.

For the individual data, I pool all subsamples of the SOEP and use the cross-sectional individual weights that are provided within the data set. In a second step, I compute group averages for movers and stayers by state and year. The sample is restricted to individuals between the ages of 18 and 64 living in eastern Germany who are in the SOEP between 1993 and 2011 for at least two consecutive years. However, I do not include observations of individuals living in Berlin in the sample as important structural changes took place during the analyzed time period which could confound the analysis.[9] After dropping all observation for which there are missing values, the sample consists of 6,704 individuals with 51,865 person-year observations. In total 348 individuals moved from eastern to western Germany between the interviews in 1993 and 2011, while four of them move repeatedly. Because I focus on who leaves eastern Germany generally, the sample is not reduced to easterners, as it is often done, but includes also return migration of westerners from the east. The migration rates in the SOEP are therefore directly comparable to the official statistics. Table 2.2 presents the average yearly migration rate for three different time periods and for two age groups. The migration rate in the SOEP is smaller throughout all time periods. This might be because a move increases the probability of dropping out of the survey and thus not being identified as a migrant in the sample. Both the official statistic and the SOEP show that the migration rate among young individuals aged 18 to 30 is considerably higher than the migration rate of individuals aged 31 to 64. This difference in migration rate increases over time.

Table 2.3 presents the summary statistics by age group, migrant category and level of regional disparities. Regarding the regional disparities, a low level is a difference (east minus west) smaller or equal to the mean difference of all states and years and a high

[9] In particular, the relocation of the seat of the parliament to Berlin in 1999 caused considerable changes of the sectoral structure and infrastructure.

difference is larger than the mean value. Note that the differences need to be interpreted differently for wages and unemployment rates as wages are on average lower and unemployment rates higher in eastern German states than in western Germany. Not the absolute value but the actual difference is analyzed. While differences in unemployment rates decrease with converging unemployment rates, differences in wages increase with converging wages.[10] Looking at summary statistics of different disparity levels should give an initial indication of a possible relation of individual characteristics of migrants and wage and unemployment differentials.

Throughout the analysis, I distinguish between movers and stayers. A mover is a person who will live in the western part of Germany in the following year. I use migrant synonymously to mover. A stayer is everyone else who lives in eastern Germany. The means of the variables show that migrants have on average a higher average level of education across all subsamples. For both age groups, the educational gap is most pronounced when regional disparities are small, i.e., when the wage difference is high and the unemployment difference is low. Similarly, wages of movers tend to be higher than those of stayers in most subsamples. The difference of average wages between movers and stayers, however, is stronger for older migrants. Unlike the level of education, the difference does not vary considerably with the level of disparities between region of origin and destination. There is no clear difference in average age between the group of movers and stayers for individuals up to 30 years of age. For individuals older than 30 years, the group of movers is on average considerably younger than the group of stayers. This age gap is highest when differences in employment opportunities are low.

When looking at the labor force status, more than 50 % of the migrants are working in the observation before migration. However, the share of movers working is rather volatile over samples and seems to vary especially with wage differentials. While the share of movers working exceeds that of stayers when the gap in wages is high, it is lower when the wage gap is small. Again, this variation is stronger for older migrants. Looking again generally at the labor force status of migrants, the second most frequent characteristic is represented by a considerably smaller share of people with about 11 to 22 %. The younger subgroup of these migrants are in training, whereas the older subgroup consists of individuals who are unemployed or non-working in the observation before migration. The share of people experiencing unemployment varies relatively little for stayers between samples but is volatile for movers. Contrary to expectations, the share of people unemployed individuals among migrants does not tend to exceed the same measure for stayers, except when differences in employment opportunities are high. This applies to both age groups. The share of young individuals in training is always higher for movers than for stayers. For older individuals the share is so small and the variation so little that I will not include this labor force category in the subsequent analysis. The

[10] In this way, a high (low) wage disparity or differential refers to a low (high) difference in wages, whereas a high (low) unemployment disparity or differential refers to a high (low) difference in unemployment rates.

Table 2.1: Variables

Variable	Definition
Dependent variables - Characteristics of the group of movers and stayers per year and state[A]	
Mover	Equals 1 if variables refer to the group of movers; 0 otherwise
Wage	Average deflated[C] current monthly net labor income in thousand Euro
Years of schooling	Average potential years of schooling; this is a generated variable which is determined by the years needed to complete the respective educational attainment
Working	Share of individuals who are working or in military or civil service
Non-working	Share of individuals who are non-working, irregularly working or on maternity leave
In training	Share of persons being student or in training
Unemployed	Share of unemployed individuals
Age	average age
Independent variables - economic variables (state level) [B, C]	
Average wage	Average yearly compensation per employee deflated by regional consumers' price inflation rate; in thousand Euro
Wage difference	Deflated average yearly compensation of employees in state of residence minus the deflated average yearly compensation of employees in western German states; in thousand Euro
Unemployment rate	Number of unemployed persons as a percentage of the labor force related to total civil-sector work force
Unemployment difference	Unemployment rate of state of residence minus average unemployment rate of western German states
Labor force participation (LFP) rate	Sum of employed and unemployed of state of residence divided by the population
Number of students	Number of students enrolled at universities or universities of applied sciences in a state at the winter term of the current year; in thousand
GPD	Deflated state-level GDP; in billion Euro

Notes: Data sources: [A] SOEP; [B] Federal Statistical Office of Germany. Data on wages and employees are taken from the regional accounts (Volkswirtschaftliche Gesamtrechnung der Länder); [C] Consumers' price inflation rates by state are taken from RWI Essen. There are no consumer price inflation rates available for Bremen, Hamburg and Schleswig-Holstein and the average values for western German states are taken instead. This also accounts for Rhineland-Palatine and Saarland until 1995.

Table 2.2: Average yearly migration rates from eastern Germany (including Berlin) to western Germany

	1993-1998		1999-2004		2005-2010	
	Ages 18-30	Ages 31-64	Ages 18-30	Ages 31-64	Ages 18-30	Ages 31-64
Official statistic	2.11	0.73	4.01	0.87	3.21	0.83
SOEP	1.30	0.30	2.45	0.54	1.83	0.58

Notes: Figures of official statistic are own calculations. *Data source:* Federal Statistical Office of Germany.

share of non-working individuals is again relatively stable across subsamples for stayers but varies quite strongly for movers between years and states with high and with low wage differences. This holds true for older and younger migrants.

In general, the difference of mean values between levels of regional disparities is higher for movers than for stayers. The variation shows a similar pattern for younger and older migrants. Yet, the variation appears to be stronger for older than for younger migrants.

Besides knowing the labor force status before migration, it is interesting to see whether it changes after migration. It has been empirically shown that migration is often an outcome of the job search process and the decision to migrate tends to go hand-in-hand with a job-change or a change of labor force status (Bartel (1979)). Tables 2.7 and 2.8 in Appendix A give an overview of the labor force status flows of movers, i.e., the labor force status categories of movers before and after migration. As the number of migration cases is rather small, these tables have to be interpreted carefully and can only be used to explore rough trends.[11] Interestingly, most of the migrants do not change their labor force status and are working in the observation before and after migration (job-to-job mover). The most prevalent change of labor force status is the undertaking of work after migration. For older migrants, this change is mainly from being unemployed before migration. For younger migrants, there is a shift from being unemployed or non-working before migration to working after migration. For both age groups the share of job-to-job movers is higher when differences in wages are high or when differences in employment opportunities are low. However, for other labor force status flows no distinct pattern can be observed as to how they vary with regional disparities.

[11] In addition, the stated labor force status in the observation before migration need not necessarily reflect the labor force status at the time of migration as it can change quickly. However, I will assume here that for most individuals the labor force status does not change in the short time period between the last interview and the actual migration.

Table 2.3: Means of independent variables, for individual level data displayed by migration category, age group, and level of disparity

Variables	Low wage difference		High wage difference		Low unemployment difference		High unemployment difference	
	stayer	mover	stayer	mover	stayer	mover	stayer	mover
Ages 18-30								
Age	24.52	23.45	24.20	24.24	24.51	24.10	24.17	23.66
	(0.47)	(2.96)	(0.56)	(2.63)	(0.51)	(3.07)	(0.51)	(2.55)
Years of schooling	11.57	12.20	11.63	13.44	11.64	13.26	11.57	12.48
	(0.32)	(2.37)	(0.46)	(2.22)	(0.43)	(2.91)	(0.36)	(1.65)
Wage[a]	0.91	0.96	0.84	0.94	0.87	1.04	0.87	0.87
	(0.08)	(0.44)	(0.08)	(0.47)	(0.09)	(0.52)	(0.09)	(0.37)
Working	0.67	0.64	0.60	0.53	0.63	0.61	0.63	0.56
	(0.09)	(0.39)	(0.07)	(0.39)	(0.09)	(0.42)	(0.08)	(0.37)
Unemployed	0.13	0.15	0.11	0.11	0.12	0.10	0.11	0.16
	(0.06)	(0.28)	(0.04)	(0.28)	(0.06)	(0.25)	(0.04)	(0.30)
In Training	0.09	0.15	0.13	0.20	0.10	0.18	0.11	0.17
	(0.04)	(0.31)	(0.04)	(0.32)	(0.05)	(0.33)	(0.04)	(0.30)
Non-working	0.12	0.05	0.16	0.15	0.14	0.11	0.15	0.10
	(0.05)	(0.19)	(0.05)	(0.24)	(0.06)	(0.24)	(0.05)	(0.22)
Observations	42	37	48	42	48	38	42	41
Ages 31-64								
Age	46.78	41.47	46.76	40.35	46.61	38.43	46.95	43.27
	(0.86)	(6.12)	(0.62)	(6.41)	(0.73)	(5.25)	(0.71)	(6.31)
Years of schooling	12.12	12.39	12.45	13.90	12.31	13.87	12.28	12.59
	(0.20)	(2.22)	(0.23)	(2.55)	(0.30)	(2.69)	(0.24)	(2.18)
Wage[a]	1.24	1.45	1.31	1.53	1.26	1.48	1.29	1.50
	(0.06)	(0.76)	(0.07)	(0.71)	(0.09)	(0.64)	(0.06)	(0.82)
Working	0.66	0.79	0.71	0.63	0.71	0.75	0.67	0.64
	(0.04)	(0.32)	(0.05)	(0.40)	(0.06)	(0.37)	(0.04)	(0.37)
Unemployed	0.17	0.17	0.15	0.16	0.15	0.11	0.17	0.22
	(0.03)	(0.28)	(0.03)	(0.32)	(0.03)	(0.23)	(0.03)	(0.35)
In Training	0.00	0.00	0.00	0.03	0.00	0.04	0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.18)	(0.00)	(0.19)	(0.00)	(0.00)
Non-working	0.17	0.04	0.14	0.18	0.15	0.11	0.16	0.13
	(0.03)	(0.15)	(0.03)	(0.32)	(0.04)	(0.29)	(0.03)	(0.25)
Observations	42	25	48	31	48	28	42	28

Notes: Standard deviation is written in parentheses. *Source:* SOEP 1993-2011 (aggregate individual-level data).

[a] Mean wage only for individual with labor income.

Table 2.4: Means of state-level independent variables

Variables	Mean	Standard deviation	Min.	Max.
State-level variables				
Average wage	26.20	0.86	23.77	28.09
Wage difference	−1.59	1.06	−4.88	0.43
Unemployment rate	17.67	2.66	10.90	22.10
Unemployment difference	8.65	2.15	3.50	13.00
LFP rate	0.53	0.01	0.50	0.55
Number of students	47.12	25.05	14.88	109.76
GDP	48.48	18.12	21.39	94.99
Observations	90			

Notes: *Source:* German Federal Statistical Office of Germany and RWI Essen (state-level data).

2.6 Regression results

The suggested relation between regional disparities and the mover's characteristics of the preceding section will be analyzed in a more formal way in this section. Besides using the volatility of wage and unemployment differentials over time, the analysis exploits variations in those variables between eastern German states. Tables 2.5 and 2.6 present the estimation results of Equation 2.1 of Section 2.4. They show how the composition of stayers and movers who are living in eastern German states changes with economic variables. The dependent variable is accordingly either average years of education, wage, age (Table 2.5) or the share of individuals with a respective labor force status (Table 2.6) of the group of movers and stayers by year and state in eastern Germany. The tables show the estimated coefficients and standard errors which are heteroskedasticity-robust and clustered by year to account for possible correlations within years. However, both tables only indicate changes in the composition of the migrants with respect to the average value of a characteristic. The share of people working among movers, for instance, can increase because people who are working migrate more often or because people who are not working migrate less often. Table 2.9 in Appendix C offers some evidence as to the causes of change in the composition. It shows how the number of movers with a certain characteristic relative to the number of stayers changes with regional disparities. Following Hunt (2006) the estimations are conducted by age groups. I distinguish between young individuals (18-30 years) and older individuals (31-64 years of age).

The mover dummy and the interaction terms are of special interest for the question at hand. The coefficients show whether persons who select themselves into the group of

Table 2.5: Effect of macroeconomic variables on the average years of schooling, wage and age of movers and stayers

Dependent variable	Years of education		Wage		Age	
	18-30	31-64	18-30	31-64	18-30	31-64
	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Mover	4.11***	2.97*	0.50	−0.05	0.78	−13.69***
	(2.96)	(2.07)	(1.43)	(−0.11)	(0.46)	(−5.12)
Wage difference	−0.12	−0.18	−0.13	0.04	−1.23	−1.17
	(−0.19)	(−0.34)	(−1.08)	(0.44)	(−1.64)	(−1.14)
Unemployment difference	−0.18	0.04	−0.02	−0.00	−0.09	−0.55
	(−0.88)	(0.21)	(−0.77)	(−0.10)	(−0.46)	(−1.30)
Wage difference*mover	0.39	0.39	0.03	−0.03	0.55	−0.84
	(1.53)	(1.31)	(0.55)	(−0.49)	(1.50)	(−1.46)
Unemployment	−0.25*	−0.17	−0.04	0.02	−0.04	0.75**
difference*mover	(−1.83)	(−1.24)	(−1.37)	(0.41)	(−0.22)	(2.35)
Average wage	−0.04	−0.20	0.08	−0.05	0.99*	2.55**
	(−0.06)	(−0.38)	(0.70)	(−0.40)	(1.81)	(2.81)
Unemployment rate	0.33**	−0.10	0.02	−0.02	0.18	0.91**
	(2.14)	(−0.52)	(0.44)	(−0.57)	(0.97)	(2.11)
Number of students	0.06*	0.03			0.08***	0.10*
	(1.99)	(1.04)			(3.04)	(1.82)
GDP			0.00	−0.00		
			(1.26)	(−0.26)		
Observations	169	146	153	139	169	146
R^2	0.268	0.254	0.096	0.086	0.116	0.496
F-statistic	12.616	26.397	7.935	9.193	8.807	28.157

Notes: Standard errors are clustered by year. The corresponding t-statistics are reported in parentheses. Not displayed: average wage rate and unemployment rate with lag of one year, state fixed effects. Results derived by OLS regression. * indicates $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* SOEP 1993-2011 and own calculations based on data of the Federal Statistical Office of Germany and RWI Essen.

Table 2.6: Effect of macroeconomic variables on the share of individuals with the respective labor force status among movers and stayers

Dependent variable	Working		Unemployed		In training	Non-working	
	18-30	31-64	18-30	31-64	18-30	18-30	31-64
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Independent variables							
Mover	0.06	0.10	−0.15	−0.29	0.10	−0.02	0.12
	(0.42)	(0.37)	(−0.72)	(−1.73)	(0.65)	(−0.15)	(0.66)
Wage difference	−0.08	0.10	0.10	−0.07	0.05	−0.07**	−0.01
	(−1.32)	(1.62)	(1.54)	(−1.66)	(1.24)	(−2.13)	(−0.12)
Unemployment difference	−0.01	0.00	0.01	−0.01	−0.01	0.00	0.00
	(−0.34)	(0.02)	(0.74)	(−0.35)	(−0.76)	(0.44)	(0.30)
Wage difference*mover	−0.03	−0.09**	0.02	0.02	−0.01	0.02	0.06**
	(−1.04)	(−2.46)	(0.66)	(0.85)	(−0.39)	(1.09)	(2.24)
Unemployment difference*mover	−0.02	−0.03	0.02	0.04*	−0.01	0.00	−0.01
	(−1.03)	(−1.09)	(1.05)	(2.01)	(−0.40)	(0.14)	(−0.37)
Average wage	0.20***	0.08	−0.05	−0.07	−0.14***	−0.01	0.02
	(4.90)	(1.13)	(−1.14)	(−1.58)	(−3.04)	(−0.21)	(0.29)
Unemployment rate	0.01	0.02	0.02	−0.00	−0.01	−0.02	0.00
	(0.70)	(0.64)	(0.81)	(−0.11)	(−0.85)	(−1.45)	(0.13)
Labor force participation rate	−1.34	2.53	−1.48	2.02	−0.50	3.32	−3.96
	(−0.36)	(0.54)	(−0.40)	(0.64)	(−0.15)	(1.21)	(−1.18)
Observations	169	146	169	146	169	169	146
R^2	0.123	0.170	0.074	0.147	0.135	0.131	0.109
F-statistic	76.100	14.973	13.694	13.288	23.702	57.706	71.091

Notes: Standard errors are clustered by year. The corresponding t-statistics are reported in parentheses. Not displayed: average wage rate and unemployment rate with lag of one year, state fixed effects. Results are derived by OLS regression. * indicates $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* SOEP 1993-2011 and own calculations based on data of the Federal Statistical Office of Germany and RWI Essen.

movers differ from stayers with respect to certain characteristics (y_{mst}), and whether this changes with economic disparities between region of origin and destination.[12] However, the interpretation of the coefficients is not straightforward. For a better understanding of the marginal effect of economic disparities on the probability that movers exhibit a certain characteristic, Appendix B includes a graphical analysis for all characteristics with significant coefficients of interaction terms. The figures show how the conditional marginal effect of being a migrant varies with regional disparities.

As the results of Table 2.5 suggest, migrants exhibit a higher level of education than the staying population when the unemployment and wage rates respectively between region of origin and destination are equal, i.e., when the difference in unemployment rates and wages equals zero. This holds true for both age groups. This might be because highly skilled individuals tend to have more particular career opportunities and less localized labor markets and achieve wage gains through better job matches even when there are no differences in wage rates. When looking at how the educational gap alters when differences of unemployment and wage rates of region of origin to destination change, we see that the coefficients of the interaction terms have the same sign but differ in their significance between older and younger migrants. For younger migrants the educational gap is more pronounced in states and at times when the difference in unemployment rates of region of origin and destination is relatively low (up to 2.6 years of schooling at a difference of 3.5 percentage points). The gap decreases with higher unemployment differentials until it is not significant at a 5 % significance level for differences in unemployment rates above a value of about 11 percentage points (see Figure 2.5 in Appendix B). As local unemployment rates and unemployment differentials respectively capture only the average risk of being unemployed, they might be more relevant for less skilled individuals than for highly skilled, given that unskilled workers are more likely to become unemployed during an adverse regional shock (e.g. McKenna (1996); Brauns et al. (1999)). As a consequence, high-skilled individuals tend to be less sensitive to changes in average employment opportunities. With this in mind, the change in the skill composition of the migrant body of younger migrants should be driven by an increasing number of less skilled movers with increasing unemployment differentials. Table 2.9 in Appendix C shows how the relative number of movers (relative to the number of stayers) with a certain level of education changes with regional disparities. It indicates that the change in the skill composition when unemployment differentials increase is mainly driven by an increase in the number of individuals with a low (10 or less years of schooling) or medium level of education (more than 10 and less than 15 years of education). The number of individuals with 15 or more years of education does not increase significantly when differences in unemployment rates rise. The coefficient for

[12] I report the results of the baseline model only. However, I also test further specifications. In order to see whether the change in the composition of the migrant body can, at least partly, be explained by changes in the composition with respect to another characteristic, I also include age, years of education and labor force status in the estimation, leaving out the respective characteristic that is analyzed. Results are not displayed but are available on request.

migrants older than 30 years of age in Table 2.5 has the same sign but is not significant at a 10 % significance level. Table 2.9 indicates that only the group with a medium educational level increases significantly when differences in employment opportunities increase.

The summary statistics suggest that migrants, both older and younger, have on average a higher wage than stayers. When looking at the mover dummy coefficients of columns 3 and 4 of Table 2.5, the average wage of a mover is not significantly different from the wage of stayers. This result does not alter with changes in regional disparities. However, the coefficient of the *wage difference*mover* variable becomes significant for the group of older individuals when controlling for years of education (results not displayed). This suggests that given their level of education, older migrants tend to earn more than stayers when wage differentials are relatively high.

Theory suggests that movers are on average younger than stayers as they are able to benefit more from potential wage gains by remaining longer in labor force, making migration more favorable for them. The results show that there is no significant age gap for younger individuals. However, the expected age gap can be found for individuals older than 30 years with movers being significantly younger when wage and unemployment differentials are zero. This age gap decreases with increasing difference in unemployment rates. The higher the difference of employment opportunities the more beneficial migration becomes for individuals with lower potential gains in migration. Table 2.9 shows that the increase in average age of movers in mainly driven by an increase in migrants aged 41 to 50 when unemployment differentials are increasing. Yet, the age gap is significant at a 5 % significance level for almost the entire range of analyzed unemployment differences[13].

Regarding labor force status, there is no such clear distinction between the group of movers and stayers as found for years of education and age. None of the coefficients of the mover dummy variable are significant, suggesting that the probability of exhibiting a certain labor force status is not significantly different between movers and stayers when there are no regional disparities. The composition with respect to labor force status changes for older migrants with wage and unemployment differentials. As expected, older migrants tend to be increasingly less often working before migration when differentials in wages and hence possible wage gains decrease. Yet only for high wage differentials the share of individuals working is higher among movers than stayers. While the share is about 30 percentage points higher when the difference in the average yearly compensation of employees is about 4,800 Euro, the difference turns insignificant at a wage gap of about 2,200 Euro per year (see Figure 2.7). The relation is reverse for the share of individuals who are non-working prior to migration. For high wage differentials, movers are significantly less often non-working. However, the share of movers who are non-

[13]The displayed unemployment and wage differentials in Appendix B range from the minimum to the maximum value of the overall sample.

working prior to migration is not significantly different from the share of non-working stayers at a wage difference of about 2,000 Euro per year (see Figure 2.9). Thus if wage differentials decrease, thereby reducing potential wage gains, it is less beneficial to migrate for individuals who are already working. Instead the share of individuals who are non-working before migration increases. However decreasing potential wage gains do not change the composition of the migrant body for younger individuals. One might speculate that younger individuals are able to benefit from wage gains resulting from migration for a longer time than older individuals. Thus, their returns to migration are more likely to compensate the costs of migration even when possible wage gains are small. Concerning the share of unemployed individuals, it increases significantly with rising differentials in unemployment opportunities for older individuals. Figure 2.8 shows that the share is significantly smaller for movers when unemployment differentials are low but becomes insignificant when unemployment differentials are at about 6 percentage points. The results of Table 2.9 suggest that the change in composition is driven by the number of individuals working and non-working which increases less among the group of movers than the number of individuals who are unemployed.

When looking generally at how regional disparities change the composition of the migrant body, the results show that the higher the regional disparities, the less distinct the group of migrants is from the group of stayers. Hence, the higher the regional disparities, the more beneficial migration becomes for a more heterogeneous group of individuals. However, regional disparities are a stronger determinant of who selects into the group of migrants for older individuals than for younger. Furthermore, the results show that differences in employment opportunities between region of origin and destination have a stronger influence on who selects into the group of migrants than wage differentials. Differences in wages affect only the composition with respect to labor force status of older migrants by making migrants less distinct from the staying population when differences decrease.

2.7 Conclusions

The present study has analyzed how individuals moving from eastern to western Germany differ from the non-migrating population and how changes in the composition of the migrant body are related to regional disparities between the two regions. The data used ranged from 1993 to 2011. During those years, migration rates, unemployment rates and wages varied greatly. Although regional disparities in wages and unemployment rates are measured on a highly aggregated state-level and only approximate regional disparities that individuals face, the analysis provides evidence for a linkage between regional disparities and the composition of the migrant body with respect to educational attainment, age and labor force status.

Previous research pointed out that differences in employment opportunities are an important determinant of migration flows (Arntz et al. (2011)). The present analysis shows that unemployment differentials are also determining the composition of the migrant body with respect to the educational level, age and the share of individuals who are unemployed before migration. While migrants tend to be younger and more educated than stayers, the group of movers becomes partly less distinct from the group of stayers with respect to the skill level and age when differences in employment opportunities increase. This result is driven by migration becoming more favorable for a more heterogeneous group of people and thereby leading to an increase in the number of people who migrate. This finding is in line with findings of Arntz (2010) who analyze east-west migration as well as internal migration between all labor market regions in Germany.

Furthermore, the results suggest that wage differentials determine the composition of the migrant body only with respect to labor force status. As possible wage gains decrease, migration becomes less favorable for older migrants who are working prior to migration but relatively more beneficial for migrants who are non-working as they have lower opportunity costs. However, this only applies to older migrants as it does not hold for younger migrants.

In general, the composition of the migrant body of individuals older than 30 is influenced more strongly by regional disparities than the younger migrant body. However, both age groups of migrants become less distinct from the non-migrating population with respect to the analyzed characteristics when regional disparities increase.

The lesson that the group of movers changes with regional disparities is likely to apply to migration in other contexts. My results suggest that in addition to the increasing flows of migration about Europe over the past few years, which have followed the tightening of regional disparities in the Eurozone resulting from the financial crisis, we might expect the composition of this migrant body might to change.

Appendix A

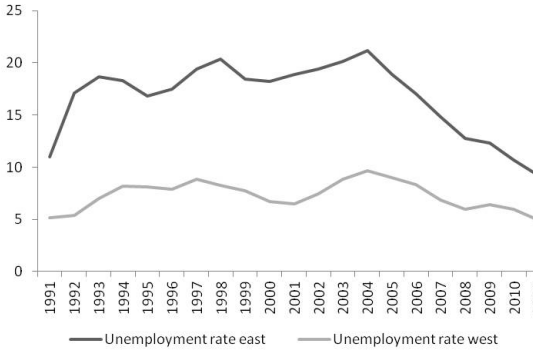

Figure 2.3: Average unemployment rates of eastern and western Germany (annual data) excluding Berlin. *Data source*: Federal Statistical Office of Germany.

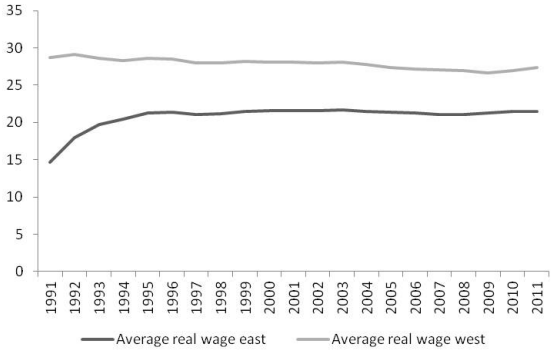

Figure 2.4: Average real wages for eastern and western Germany (annual data) excluding Berlin. *Data source*: Own calculation based on data from the Federal Statistical Office of Germany.

Table 2.7: Percent of movers (ages 18-30) in respective labor force category in the observation before and after migration

Before migration	After migration			
	Working	*Unemployed*	*In training*	*Non-working*
Working				
Low wage difference	54.5	2.4	3.6	7.0
High wage difference	50.6	6.0	0.0	2.2
Low unemployment difference	56.7	1.9	3.0	4.4
High unemployment difference	47.8	7.0	0.0	4.0
Unemployed				
Low wage difference	13.9	2.0	0.0	2.6
High wage difference	4.4	1.4	0.0	0.4
Low unemployment difference	7.2	0.0	0.0	1.4
High unemployment difference	9.5	3.3	0.0	1.2
In training				
Low wage difference	5.9	0.0	3.5	0.0
High wage difference	6.9	0.3	5.9	0.4
Low unemployment difference	4.4	0.0	5.7	0.0
High unemployment difference	8.5	0.4	4.1	0.4
Non-working				
Low wage difference	2.1	0.0	2.5	0.0
High wage difference	10.8	2.0	6.2	2.5
Low unemployment difference	7.2	1.2	6.9	0.0
High unemployment difference	7.2	1.2	2.5	3.0

Table 2.8: Percent of movers (ages 31-64) in respective labor force category in the observation before and after migration

Before migration	After migration			
	Working	*Unemployed*	*In training*	*Non-working*
Working				
Low wage difference	66.5	8.1	0.0	5.3
High wage difference	49.9	8.1	0.3	1.6
Low unemployment difference	66.8	6.8	0.4	1.5
High unemployment difference	44.7	9.8	0.0	5.2
Unemployed				
Low wage difference	9.7	6.3	0.0	0.0
High wage difference	16.3	2.9	0.0	1.2
Low unemployment difference	4.4	3.4	0.0	0.0
High unemployment difference	24.9	5.5	0.0	1.6
In training				
Low wage difference	0.0	0.0	0.0	0.0
High wage difference	9.2	0.0	0.0	0.0
Low unemployment difference	9.4	0.0	0.0	0.0
High unemployment difference	0.0	0.0	0.0	0.0
Non-working				
Low wage difference	0.0	0.0	0.0	4.1
High wage difference	5.1	0.5	0.0	4.9
Low unemployment difference	2.5	0.5	0.0	4.3
High unemployment difference	3.5	0.0	0.0	4.8

Appendix B

The following panels show the graphical analysis of marginal effects of unemployment or wage differentials on who selects into the group of migrants. The right-hand panel shows the size of the gap in linear prediction of the analyzed characteristics between movers and stayers and how it changes with different unemployment or wage differentials. It is measured at mean values of all other variables. The left-hand panel shows the quadratic curve fit of linear predictions by unemployment or wage differential for movers and stayers separately. Here the prediction is calculated for every observation and is based on their respective values of co-variates. Therefore the slopes do not necessarily correspond to the estimated coefficients as other factors are not held constant.

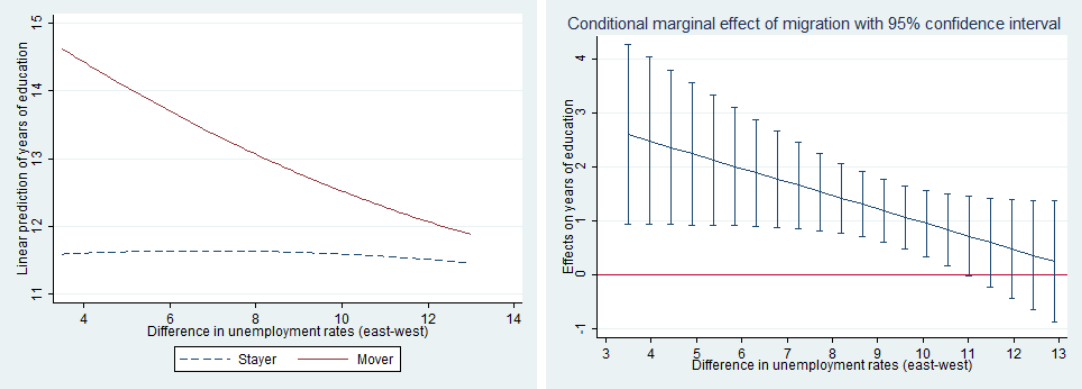

Figure 2.5: Fitted quadratic curve of the linear prediction of years of education (left panel) and conditional marginal effect of migration on years of education (right panel), both for ages 18-30.

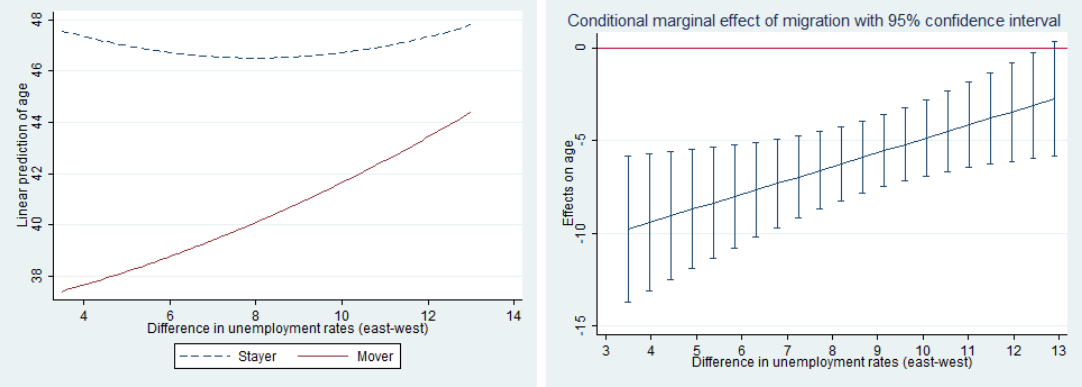

Figure 2.6: Fitted quadratic curve of the linear prediction of age (left panel) and conditional marginal effect of migration on age (right panel), both for ages 31-64.

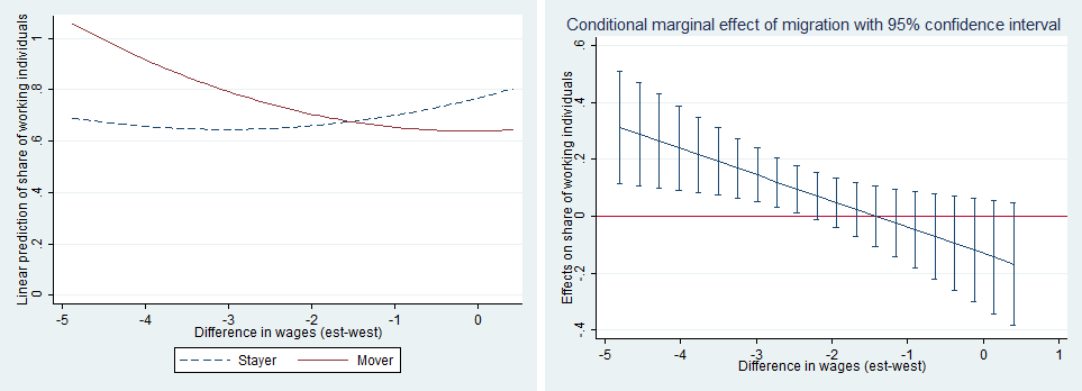

Figure 2.7: Fitted quadratic curve of linear predictions of the share of working individuals (left panel) and conditional marginal effect of migration on the share of working individuals (right panel), both for ages 31-64.

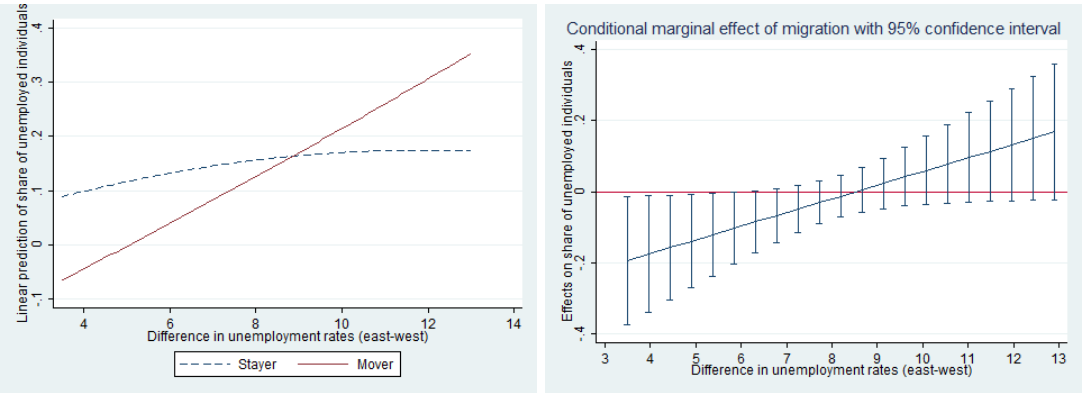

Figure 2.8: Fitted quadratic curve of linear predictions of the share of unemployed individuals (left panel) and conditional marginal effect of migration on the share of unemployed individuals (right panel), both for ages 31-64.

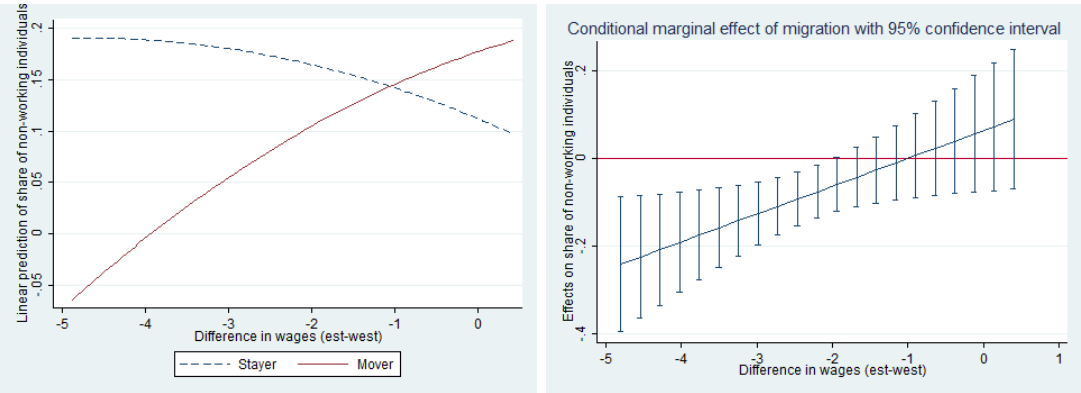

Figure 2.9: Fitted quadratic curve of linear predictions of the share of non-working individuals (left panel) and conditional marginal effect of migration on the share of non-working individuals (right panel), both for ages 31-64.

Appendix C

Table 2.9: Effect of regional disparities on the ratios of the number of movers to stayers who exhibit a certain characteristic

Dependent variable	Age 18-30				Age 31-64		
Mover-to-stayer-ratio	Working	Unemployed	In training	Non-working	Working	Unemployed	Non-working
Independent variable							
Wage difference	0.03	0.27	1.43	0.64***	−0.06	0.00	0.09*
	(0.09)	(0.38)	(1.37)	(0.21)	(0.05)	(0.06)	(0.04)
Unemployment difference	0.15	0.73**	0.22	0.36	0.02	0.07*	0.07*
	(0.12)	(0.34)	(0.43)	(0.28)	(0.03)	(0.04)	(0.04)
Observations	90	90	90	90	90	90	90
R^2	0.107	0.147	0.073	0.062	0.065	0.041	0.121

Dependent variable	Age 18-30			Age 31-64			
Mover-to-stayer-ratio	Low	Medium	High	Low	Medium	High	level of education[a]
Independent variables							
Wage difference	−0.48	0.50	−0.29	0.17	−0.03	0.00	
	(0.38)	(0.29)	(0.67)	(0.24)	(0.04)	(0.07)	
Unemployment difference	0.38**	0.27**	0.02	−0.29	0.06***	−0.03	
	(0.15)	(0.10)	(0.54)	(0.20)	(0.02)	(0.04)	
Observations	90	90	90	90	90	90	
R^2	0.154	0.191	0.035	0.104	0.105	0.018	

Dependent variable							
Mover to stayer ratio	Age 18-22	Age 23-26	Age 27-30	Age 31-40	Age 41-50	Age 51-64	
Independent variables							
Wage difference	0.42	−0.01	0.22	0.00	−0.02	0.01	
	(0.35)	(0.21)	(0.19)	(0.11)	(0.09)	(0.04)	
Unemployment difference	0.45*	0.21	0.15	0.02	0.06*	0.01	
	(0.24)	(0.15)	(0.17)	(0.07)	(0.03)	(0.02)	
Observations	90	90	90	90	90	90	
R^2	0.242	0.062	0.098	0.051	0.054	0.051	

Notes: Coefficients are derived by OLS regression. Standard errors are adjusted for clustering around years and are reported in parentheses. Not displayed: state fixed effects. Significance levels: * indicates 10%, ** 5%, *** 1%. *Source:* SOEP 1993-2011 and own calculations based on data of the Federal Statistical Office of Germany. [a] Low level of Education refers to 10 or less years of schooling, medium level to more than 10 and less than 15 years, and high level refers to 15 or more years of education.

3 Generalized trust and prosocial behavior

Abstract

There is considerable empirical evidence from both lab and field experiments that people frequently engage in prosocial behavior. I develop a simple model of the emergence of prosocial behavior in encounters between strangers. By abstracting from the possibility of reputation building and punishment between anonymous partners, I remove the main motives for prosocial behavior and reduce it to a simple non-strategic decision. The motivation to behave prosocially is then principally intrinsic, based on altruism and a taste to conform to the behavior of others. In this way, individual decisions are conditional on the behavior of others. Emerging equilibria can then demonstrate the occurrence of prosocial or cooperative behavior in a society. In a second step, I analyze whether the model's predictions are consistent with the empirical evidence on the link between beliefs and prosocial behavior using data on blood donations.

JEL: D03 D64 D83
Keywords: trust, beliefs, prosocial behavior, conditional cooperation

[0]I would like to thank Eberhard Weck, Friedrich-Ernst Düppe und Cornelia Kruse for their valuable information on the blood donation system of the German Red Cross and for their effort for providing the data used in this analysis.

3.1 Introduction

There is overwhelming evidence both from experiments and everyday experience that motivation for human behavior is more complex than simply a maximization of material payoffs. Classical models based on this assumption often fail to predict behavior in social interactions. Prosocial behavior is one important type of conduct that classical models frequently fail to explain; that is, an action that mainly benefits others at a cost to oneself. Here, we can refer to diverse modes of behavior such as helping strangers, tax compliance, voting, blood donation and giving to charities.

This paper relates prosocial behavior to generalized trust; that is, it relates it to positive expectations about the behavior of others.[1] This kind of trust denotes the feeling that a person has about the behavior of other people she does not know personally. The concept of generalized trust should be distinguished from particularized trust. The latter refers to trust between people who know each other and are hence able to base their expectation about the other's behavior on experience from face-to-face interactions or information via third parties. Generalized trust is the extension of interpersonal trust to people whom the trusting individual does not know and on whom she hence has no direct information.

The concept of generalized trust is an integral part of the literature on social capital. Putnam (1995) defined social capital as "features of social life - networks, norms and trust - that enable participants to act together more effectively to pursue shared objectives" (Putnam (1995) p. 664 f.). The particular importance of generalized trust has been emphasized repeatedly in the literature on social capital (eg. Rothstein and Stolle (2008); Stolle (2002)). Experimental evidence shows fairly conclusively the positive effect of generalized trust upon cooperation and collective action, especially in one-shot interactions or multiple n-person games without a specific partner. The importance of generalized trust has been increasingly acknowledged for various economic phenomenons, including growth (e.g. Knack and Keefer (1997)) and civic participation (e.g. La Porta et al. (1997)).

Prosocial behavior is driven by both preferences and beliefs. Empirical evidence suggests that an individual's inclination to cooperate in social dilemmas is positively related to her perceived willingness to cooperate of other members of the society. Beliefs about the behavior of others may therefore promote cooperative behavior, even in anonymous

[1] Definitions of trust very greatly in the literature. I use a very general definition here which only refers to positive beliefs about the behavior of others. However, most studies follow Coleman's concept of trust (Coleman (1994)) and use a behavioral definition of trust which is based on the actual action of placing trust in another person as for example done in trust games. Trusting behavior depends not only on expectations about the others trustworthiness but also on risk preferences and social preferences. Hence, the definition used here deviates from the often used behavioral definition in the sense that it refers to the beliefs part only.

situations where the dominant strategy is not to contribute at all. Voluntary cooperation and contributions in anonymous settings are difficult to explain through conventional models.

Yet, beliefs or trust are rarely accounted for in economic models. In this paper, I incorporate beliefs about the behavior of others into a simple theoretical model of prosocial behavior in encounters between strangers. This kind of setting is particularly interesting, being that interactions between anonymous partners are increasingly frequent and tend to replace face-to-face interactions in many areas of life.[2] The decision problem is modeled as a helping game with the alternatives to help or to shirk. Within this framework, I abstract comprehensively from possibilities of direct reciprocity, punishment and reputation building which are among the main driving forces of cooperation in social dilemmas (Nowak (2006)). Hence, there is no incentive to behave prosocially due to strategic reasons. Instead motives are mainly intrinsic: behavior is driven by altruistic preferences and a taste to conform to the behavior of others. The desire to adjust to the behavior of others is the channel that links beliefs and the individual decision to help. There are potentially underlying motivations, such as the individual's desire to reciprocate the behavior of others indirectly or to comply to a descriptive norm[3]. However, the behavioral consequence is the same: the more others are expected to behave prosocially, the higher is the internal incentive to follow this behavior. In this way, individuals perform prosocial actions conditionally and decisions become interdependent. As a consequence, higher generalized trust in a population may lead to a higher level of prosocial behavior. Taking account of this notion of interdependent behavior, this work will be closely related to models of social norms and cooperation where the strength of norms is dependent on the number of individuals complying to the norm (e.g. Traxler and Spichtig (2011)).

The model is able to explain the existence of high levels of prosocial behavior in societies in spite of the lack of formal or informal controls. When considering heterogeneity in altruistic preferences, it also gives a reason for the coexistence of individuals who always follow one strategy with those who condition their behavior on the actions of others. The interdependence of behavior implies the possibility of multiple equilibria. The equilibrium levels of prosocial behavior which are possible in a society depend on

[2]Stolle (2002) argues that "[i]ncreasing spatial and social mobility, growing role segmentation and growing communication make social interactions more fluctuating, more situation-specific and much more diversified.[...] [M]any of our transactions increasingly involve people whom we do not know". This increases the importance of generalized trust in social interactions (Stolle (2002) p. 399).

[3]Social psychologists distinguish two types of norms. There are norms which inform individuals about what kind of behavior is typically approved and disapproved - those are injunctive norms (Cialdini and Goldstein (2004); Schultz et al. (2007)). A descriptive norm reflects what is commonly done in a particular situation. In this way, there is no single universal behavior that is universally socially accepted, but the socially accepted behavior can change depending on which behavior is perceived to be usually followed by others. The endogenous character of the norm is in contrast to the conventionally used notion of norm in economic modeling as found, for instance in the literature of tax morale (e.g. Myles and Naylor (1996); Kim (2003); Fortin et al. (2007))

the cost-benefit ratio of helping and the level of bias of beliefs. Even small changes in beliefs or the cost-benefit ratio will provoke changes in the level of prosocial behavior because individuals who are almost indifferent to the choice of helping and shirking will adjust their behavior.

In a final step, I analyze whether the model's predictions for the relationship between beliefs and prosocial behavior can be found in real world cases. In view of data limitations, the empirical analysis was not conducted at the individual level but on an aggregate (state) level. Using data on blood donations in Germany, I analyze how the number of "first-time-donors" and the number of donations by repeat donors change with varying levels of trust and the perceived benefit of donating blood within the population. The model predicts that small changes in those factors that determine willingness to help would primarily affect the number of "first-time-donors", while leaving the behavior of repeat donors mainly unchanged. The analysis confirms the prediction. A change in the level of generalized trust does not cause a significant change in behavior of those who donate blood repeatedly but of those who did not donate before. This pattern also applies to the perceived benefit of donation. The analysis hence supports the notion that individuals' tendency to behave prosocially is conditional on beliefs about the behavior of others.

The paper is organized as follows. The next section provides an overview of prosocial behavior in social dilemma situations of the experimental literature. The stylized facts derived here form the basis for the model of prosocial behavior which is outlined in Section 3. This section describes the problem of individual decision - whether to help or to shirk - and derives the determinants of prosocial behavior on both the individual and on the population level. The fourth section extends the model to encompass heterogeneous beliefs, while the fifth section presents the set-up of the empirical analysis and discusses the results obtained. The last section summarizes and concludes with a discussion of some directions for future research.

3.2 Literature on prosocial behavior in non-strategic situations

The prosocial behavior of individuals has been studied extensively in lab experiments. Public good games, dictator games and helping games are good instruments for analyzing prosocial behavior because personal contributions mainly increase the payoff of others. In all of these games, the dominant strategy is to give nothing in order to maximize economic payoffs. However, it has been shown empirically that much more cooperation takes place than has been predicted by standard theory, even in anonymous situations.[4]

[4]See Camerer (2003) and Engel (2011) for an overview of evidence on dictator games.

In dictator games, for instance, individuals tend to give on average between 20 % and 30 % of their endowment to the other player (Camerer (2003)).

There is a solid body of empirical evidence that individuals do care about how their behavior compares to the actions of others. Informing individuals of the decision of others tends to change the individual's behavior being that they adjust to the amount that has been given by others. This has been shown in lab experiments with dictator games (e.g. Krupka and Weber (2009); Duffy and Kornienko (2010)) and public good games (e.g. Kurzban et al. (2001); Fischbacher et al. (2001); Zafar (2011)) as well as in field experiments on charitable giving (e.g. Chen et al. (2010); Shang and Croson (2009); Frey and Meier (2004b); Andreoni and Scholz (1998)) and contributions to an online community (Chen et al. (2010)) where information on the amount given by others or the share of people giving changed contribution behavior in the way that individuals tend to adjust to the mean contribution.

If there is no information available on the others' behavior, individuals also tend to give more when they belief that others are giving more (e.g. Iriberri and Rey-Biel (2008); Zafar (2011); Thöni et al. (2012)). However, this type of correlation of belief and contributions does not establish causation. The correlation may well be due to a false consensus effect which has caused individuals to believe that others tend to contribute the same as they do (Ross et al. (1977)). To overcome this problem, Fischbacher et al. (2001) developed an experiment where participants indicate how much they would contribute to a public good given all possible average contributions of the other group members. They find that approximately 50 % of the people were conditional cooperators who increase their contributions when others contribute more. On the other hand, about 25 % where always free-riding and the rest showed hump-shaped or more complicated patterns. The experiment has been replicated in similar settings (e.g. Burlando and Guala (2005); Kocher et al. (2008); Herrmann and Thöni (2009)). The majority of participants in those public goods experiments appear to be conditional cooperators. The behavior of other participants can be grouped into three categories: cooperators, free-riders or noisy behavior that cannot be readily categorized. The correlation of beliefs and voluntary contributions was also found when participants play public good games repeatedly and update their beliefs accordingly. Fischbacher and Gächter (2010) find that when people learn about the behavior of others they update their beliefs about how much others are contributing in the next round and so will adjust their behavior.

Framing is used as a way to explore subjects' beliefs in experiments. This approach is based on the notion that framing (like the wording of instructions or the name of the game) gives subjects a cue about a comparable social situation. In this situation, individuals then form their beliefs about the behavior and expectations of others which in turn affects their behavior (Dufwenberg et al. (2011)). Ellingsen et al. (2012) conduct one-shot prisoner's dilemma games in an anonymous environment to test whether framing affects preferences or beliefs. They suggest that - within this setting - social

framing effects work primarily through beliefs about opponent behavior.[5] Although the setting they use is anonymous, there is the possibility that beliefs about the opponent's expectations will exert an influence on behavior. Changes in behavior may be triggered by guilt aversion or self-image. Ockenfels and Werner (2014) use a more subtle mean to induce systematic shifts in beliefs about others behavior. When asking dictators in dictator games to estimate what other dictators give and what recipients expect, they manipulated the scales of possible responses, thereby shifting their beliefs about the behavior and expectations of others. The authors found that estimates, beliefs and actual transfers move in the same direction as the scale manipulation. Yet, the effect is much larger and only significant when the expectations of recipients are estimated by participants.[6]

A similar tendency has been observed in laboratory experiments when beliefs about what others are doing are not explicitly elicited. Instead, a wider measure of beliefs is applied; namely, a measure of generalized trust. Gächter et al. (2004); Anderson et al. (2004) and Thöni et al. (2012) use survey questions[7] to elicit the individual's level of trust in order to investigate the link between trust and voluntary contributions in public good games. They principally find a positive correlation between generalized trust and voluntary contributions. However, the causal relationship is ambiguous. No study has yet been conducted which investigates how exogenous changes in individual trust level change prosocial behavior.

Though experiments vary in their settings, there are two stylized facts that can be drawn from these studies: (i) individuals differ with respect to their preferences for cooperation, and (ii) beliefs about other people's willingness to contribute matter. There are two major competing explanations for prosocial behavior which is conditional of the behavior of others.[8] It may be triggered by notions of fairness such as reciprocity. Or it might be a result of the wish to behave appropriately by conforming to a norm.[9] In both cases, beliefs about the behavior of others are taken as a signal either for an appropriate or fair behavior. A few studies try to discriminate whether individuals engage in social comparison due to reciprocity or conformity (Bardsley and Sausgruber

[5] For more literature on social framing effects, see e.g. Dreber et al. (2013) and references therein.

[6] Ockenfels and Werner suggest two explanation for this phenomenon which both cannot be tested with the generated data. First, dictators are more motivated by guilt aversion rather than conforming to a norm. The second explanation is that dictators are more stable regarding their priors about the behavior of others in the same role, as opposed to priors about others in the recipient role.

[7] There are several survey questions that try to capture different aspects of trust. However, the standard trust question of the General Social Survey ("Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people' ') is primarily taken to investigate the link between trust and different economic phenomena.This is a much broader measure than eliciting beliefs about others' behavior in a specific situation.

[8] Other explanations include competitive motives and inequality aversion. See Fehr and Schmidt (2006) and Meier (2006) for a survey of theories.

[9] Cialdini and Goldstein (2004) argue that norms for appropriate behavior are often deduced from behavior of others. The term norm then refers to a descriptive norm.

(2005); Falk (2004); Bohnet and Zeckhauser (2004)) but the results are unclear and both would appear equally valid as a driving motivation.

The next section outlines a framework for a link between beliefs about other people's and one's own behavior.

3.3 A simple model of prosocial behavior

This section sketches a framework for thinking about the interaction of beliefs about the actions of others, altruistic preferences and prosocial behavior. I formalize the relationship based on stylized facts from experiments which are briefly reviewed in Section 3.2. The model is based on a simple helping game.

Consider the following situation. There are randomly chosen pairwise encounters between members of a large population. When they meet, one subject is in the need of help and can only be assisted by the other subject. The latter can either cooperate and thus help the one in need or shirk. Her move is denoted by $x_{it} \in \{0, 1\}$ where $x_{it} = 1$ when she helps and $x_{it} = 0$ when she shirks in period t. Shirking is costless but adds nothing to the payoff of the other agent. Cooperation costs c but results in a payoff b for the other individual where $b > c > 0$. The payoff $\Pi^i(x_{it})$ for move x_{it} is $\Pi^i(x_{it}) = -x_{it}c$ for agent i and $\Pi^j(x_{it}) = x_{it}b$ for agent j. Hence, cooperation is socially efficient.

Preferences

The two subjects are strangers who cannot rely on either past or future behavior to establish mutual benefit from cooperation. In addition, these encounters are not directly observable by other members of the population. Being that the population is large and individuals are matched randomly, it is the case that the same individuals do not need to meet again. In this way, punishment or reputation building are impossible and the decision is therefore non-strategic, with a strong incentive to free-ride. Yet, empirical evidence shows that a substantial share of people behave prosocially in this kind of situations.

One of the motives that drives prosocial behavior is altruism: the unconditional goodwill towards others. If a member of the population derives sufficient utility from benefiting others, the individual will decide to cooperate. On the contrary, a selfish individual will decide to shirk. However, as seen above, individuals do not decide independently of what they expect others would do in their situation. Despite their preference for behaving cooperatively or selfishly, they might comply to what they perceive to be the norm or reciprocate the behavior expected of others. Their behavior is subsequently

conditional on the perceived behavior of others. Although encounters are not directly observable, individuals have information about the share of individuals, (p_{t-1}), who received help in the previous period. This information forms their beliefs. In this sense, p_{t-1} reflects the individual level of generalized trust.[10] Beliefs are updated at the end of each period. The belief about the behavior of others is not necessarily equivalent to the share of cooperatively behaving agents in the current period. Only if the population coordinates on an equilibrium level of cooperative behavior, beliefs will be unbiased.

In order to model conditional cooperative behavior, the functional form of person i's preference draws heavily on the preference-model for reciprocal behavior developed by Levine (1998):

$$U(x_{it}) = \Pi^i(x_{it}) + \alpha \Pi^j(x_{it})$$
$$\alpha = \frac{a_i + \lambda\ p_{t-1}}{1+\lambda} \quad \text{with } \lambda > 0$$

Although the model is based on the idea of reciprocity, it applies to the motive of complying to a descriptive norm as well. The coefficient of the own payoff Π^i is normalized to one for all individuals. The weight on person j's payoff, however, varies over individuals and time as it depends on the parameters a_i and p_{t-1}. $a_i \in (0,1)$ is person i's level of unconditional goodwill towards j. If $a_i > 0$, j's payoff enters i's utility function; i is altruistic to some degree. If $a_i = 0$, she is selfish. Let the individual level of altruism, a_i, be distributed according to the probability density function $\phi(a)$ and the cumulative distribution function $\Phi(a)$ in the population. Besides the individual's preference for behaving prosocially reflected in a_i, the level of utility depends on i's expectation about the behavior of others, i.e. her level of generalized trust p_{t-1}. The element which makes individuals care about what others are doing is the parameter λ. The size of λ determines the weight that the behavior of others has for the own utility. It integrates an element of fairness or descriptive norm compliance[11] into the decision which is shared by the society. The notion of fairness or social norm is assumed to be enforced through internal sanctions like shame, guilt, loss of self-esteem or embarrassment anxiety (Elster (1998)). As such, it directly affects the utility. If $\lambda \neq 0$, then individual i's utility changes in accordance with the perceived behavior of other people. Individual i's choice would be unaffected by her perception about the behavior of other only if $\lambda = 0$. Here,

[10] In this setting generalized trust is formed solely on the basis of beliefs about others' willingness to cooperate. As a result, beliefs and trust can and will be used synonymously here. A high level of trust is equal to positive beliefs about the cooperativeness of other members of the society. A higher emphasis on generalized trust in its wider definition will be given in the empirical analysis.

[11] Remember, a descriptive norm reflects what most people do in a specific situation. In contrast to a injunctive norm which specifies what ought to be done in a given situation, the norm is defined only by the perceived behavior of others. The more people behave in a certain way the stronger is the desire to conform to this behavior.

I assume that $\lambda > 0$ which reflects a taste for either reciprocating or conforming to the behavior of others[12] and is therefore in line with findings in the literature on experimental economics (see the examples in Section 3.2 for examples). The higher the perceived share of cooperative people in the population the higher is the weight α for the benefit of person j in the utility function of individual i.

Person i will decide to cooperate if $U(x_{it} = 1 \mid a_i, p_{t-1}) > U(x_{it} = 0 \mid a_i, p_{t-1})$. This is true if and only if

$$-c + \frac{a_i + \lambda\ p_{t-1}}{1+\lambda} b \quad > \quad 0 \tag{3.1}$$

or alternatively

$$a_i \quad > \quad \frac{c}{b}(1+\lambda) - \lambda\ p_{t-1} \tag{3.2}$$

$$a_i \quad > \quad \hat{a}(p_{t-1}) \tag{3.3}$$

$$\hat{a}(p_{t-1}) \quad \equiv \quad \frac{c}{b}(1+\lambda) - \lambda\ p_{t-1}. \tag{3.4}$$

Aggregate prosocial behavior

The choice to behave prosocially depends on both preferences and beliefs. Individuals differ in their altruistic preference (represented by the value of a_i). Beliefs are updated in each period and thus may change over time. In this way, the decision to behave prosocially might vary across individuals and over time. The action of individual i in period t can be described as

$$x_{it} = x(a_i, p_{t-1}) = \begin{cases} 1 & \text{for } a_i > \hat{a}(p_{t-1}) \\ 0 & \text{for } a_i \leq \hat{a}(p_{t-1}) \end{cases}. \tag{3.5}$$

This means that, individuals with $\hat{a}(1) > a_i > \hat{a}(0)$ adjust their behavior to that of others. Although they will shirk when the level of cooperation in the population is sufficiently low, they will cooperate if the level of cooperation is sufficiently high. Consequently, it can be claimed that prosocial behavior does not need to be primarily motivated by altruism and altruism does not necessarily produce prosocial behavior. However, individuals with $a_i > \hat{a}(1)$ or $a_i < \hat{a}(0)$ will always cooperate or shirk respec-

[12] In case $\lambda < 0$, the individual exhibits a taste to act contrary to the behavior of others

tively. It is clear from Equation 3.4 and Expression 3.5 that the following properties of individual behavior can be derived:

$$\frac{\partial P(a_i > \hat{a})}{\partial p_{t-1}} > 0, \ \frac{\partial P(a_i > \hat{a})}{\partial \frac{c}{b}} < 0 \ \text{ and } \ \frac{\partial P(a_i > \hat{a})}{\partial \lambda} \lessgtr 0 \tag{3.6}$$

The threshold for behaving cooperatively changes with the beliefs about the cooperativeness of others. And so does the share of cooperatively behaving subjects. The individual inclination to behave prosocially increases with the perceived willingness to behave prosocially on the part of others. This is a direct result of the taste to conform to the behavior of others. As more individuals shirk, the utility associated with behaving prosocially decreases and shirking becomes relatively more beneficial.

Expression 3.6 shows also how the propensity varies with exogenous variables. The individual willingness to help decreases with the cost-benefit ratio. Helping becomes relatively more costly if the ratio increases and therefore less attractive. The effect of the norm parameter λ on the individual propensity to help cannot be determined generally but depends on the relative size of the beliefs about the share of cooperative individuals in the population p_{t-1} and the cost-benefit-ratio.

If the behavior of others is common knowledge, then the expected share of individuals who behave cooperatively can be derived from the distribution of the altruistic trait within the population:

$$p_t = 1 - \int_0^{\hat{a}(p_{t-1})} \phi(a) \mathrm{d}a \tag{3.7}$$

$$p_t = 1 - \Phi(\hat{a}(p_{t-1})) \tag{3.8}$$

At the same time, p_t is also the probability that someone in need of help receives help when matched with a random person. Although the propensity of a person to help varies across subjects, the probability of receiving help is the same for all individuals. Analog to expressions 3.6 for individual behavior, the properties of the aggregate behavior - the share of cooperative individuals in the population - are

$$\frac{\partial p_t}{\partial p_{t-1}} > 0, \ \frac{\partial p_t}{\partial \frac{c}{b}} < 0 \ \text{ and } \ \frac{\partial p_t}{\partial \lambda} \lessgtr 0. \tag{3.9}$$

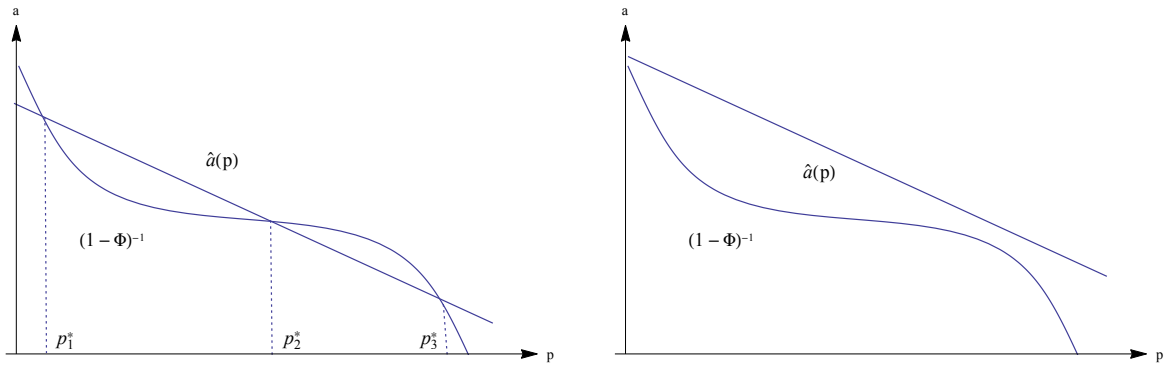

Figure 3.1: Illustration of possible equilibrium states with homogeneous beliefs

Equilibrium

In general, an equilibrium is given when

$$p^* = 1 - \Phi(\hat{a}(p^*)) \tag{3.10}$$

$$\text{with } p^* = p_t = p_{t-1}. \tag{3.11}$$

The share of individuals for whom the degree of altruism is higher than the threshold level for cooperation ($a_i > \hat{a}(p^*)$) is exactly p^*. The equilibrium level of cooperative individuals is self-sustained, meaning that the share of cooperatively behaving agents in period $t-1$ will result in the same share of cooperative individuals in period t. Only changes in the exogenous variables will cause the equilibrium level to change in the manner derived in Expressions 3.9.

Figure 3.1 illustrates possible equilibrium states of the number of cooperators in a population. Here, the altruistic trait (a_i) is assumed, approximately, to be distributed normally. The function $\hat{a}(p_{t-1})$ displays how the threshold level for cooperation changes with p_{t-1} (see Equation 3.4). The function $(1-\Phi)^{-1}$ is the inverse of Equation 3.8 and depicts the share of individuals whose degree of altruism is above a certain level of a. Intersections of both functions represent equilibria and there exists at least one stable equilibrium. If the maximum level of altruistic behavior, $\max((1-\Phi)^{-1})$, is below the threshold for cooperative behavior $\hat{a}(p)$ for all values of p, then the only possible equilibrium is at $p^* = 0$. This state where nobody behaves cooperatively is illustrated in the right hand panel of Figure 3.1. In this case, even individuals with the highest degree of altruism in the population are unwilling to help. Given that $(1-\Phi)^{-1}$ exceeds $\hat{a}(p)$, there is at least one equilibrium with a positive share of cooperative individuals, $p^* > 0$.

This situation is depicted in the left hand panel of Figure 3.1. In the illustrated example, there are three possible equilibria. While the intermediate equilibrium p_2^* is unstable, the equilibria at a high level and a low level of cooperative behavior respectively are asymptotically stable. In those equilibria, the condition for stability

$$\left| \frac{\partial \ (1 - \Phi(a(p^*)))^{-1}}{\partial \ p} \right| \geq \left| \frac{\partial \ \hat{a}(p^*)}{\partial \ p} \right| \tag{3.12}$$

is satisfied. This means that the system will restore the equilibrium when small deviations occur.

If the share of cooperators in the population is common knowledge, as assumed here, one of the possible equilibria will emerge. When encounters are not directly observable, the assumption that there is perfect information is fairly strong. This assumption will be relaxed for the purposes of the following section.

3.4 Heterogeneous beliefs

Individuals do not necessarily know how others would behave in a specific situation. Instead, they hold some prior beliefs about the probability $\pi_{it} \in (0, 1)$, that someone would behave prosocially. These beliefs are updated at the end of each period and reflect the individual's level of generalized trust.

The above derived model can easily be adapted to heterogeneous beliefs. Assume that individual beliefs are distributed according to some functional form with $\theta(\pi_t) \sim (\Pi_t, \sigma_t)$ denoting the probability density function and $\Theta(\pi_t)$ the cumulative distribution function. Here beliefs may be formed in a variety of unspecified ways. Yet, they are assumed to be uncorrelated with the altruistic trait which would apply, for instance, to a situation where the individual's perception is determined by information on a number of randomly selected situations in which individuals decide about behaving prosocially. In addition, beliefs may be based on external information which is common to everyone. The mass media, for instance, are one such a source of information both inexpensive and accessible to many individuals. External information may impact upon the perceived probability, acting like small shocks which can be either positive or negative in shifting the average belief. The possibility of shocks is not modeled explicitly here; however, the influence of shocks or systematic bias will be discussed below. Following Equation 3.3, the decision of individuals must take into account their individual beliefs. When considering individual beliefs, an individual will behave prosocially if

$$-c + \frac{a_i + \lambda\ \pi_{it}}{1+\lambda} b > 0 \tag{3.13}$$

or

$$\pi_{it} > \hat{\pi}(a_i), \tag{3.14}$$

$$\hat{\pi}(a_i) \equiv \frac{c}{b}\frac{(1+\lambda)}{\lambda} - \frac{a_i}{\lambda}. \tag{3.15}$$

The individual propensity to cooperate is

$$p_{it} = prob\left\{\pi_{it} > \hat{\pi}(a_i)\right\} \tag{3.16}$$

$$= 1 - \int_0^{\hat{\pi}(a_i)} \theta(\pi_t)\ \mathrm{d}\pi_t \tag{3.17}$$

$$= 1 - \Theta(\hat{\pi}(a_i)). \tag{3.18}$$

When the weighted average of individual beliefs, p_{it}, is formed, these propensities yield the probability that someone will choose to behave prosocially. Hence, the expected share of people who provide help in the population is:

$$P_t = \int_0^1 p_{it}(a_i) \cdot \phi(a)\ \mathrm{d}a \tag{3.19}$$

$$P_t = \int_0^1 \left(1 - \int_0^{\hat{\pi}(a_i)} \theta(\pi_t)\ \mathrm{d}\pi_t\right) \cdot \phi(a)\ \mathrm{d}a \quad \text{with} \quad \theta(\pi_t) \sim (\Pi_t, \sigma_t) \tag{3.20}$$

Consequently, the following properties can be derived:

$$\frac{\partial P_t}{\partial \frac{c}{b}} < 0 \ \text{ and } \ \frac{\partial P_t}{\partial \lambda} \lessgtr 0 \tag{3.21}$$

Here, the equilibrium is not characterize by a fixed point as before but is rather a basin of attraction. This is due to the stochastic character of the formation of individual beliefs. It is impossible to derive the precise share of cooperators, only the expected share of cooperatively behaving individuals in a population can be derived. Following Equation 3.20, the expected share of cooperators in an equilibrium state is

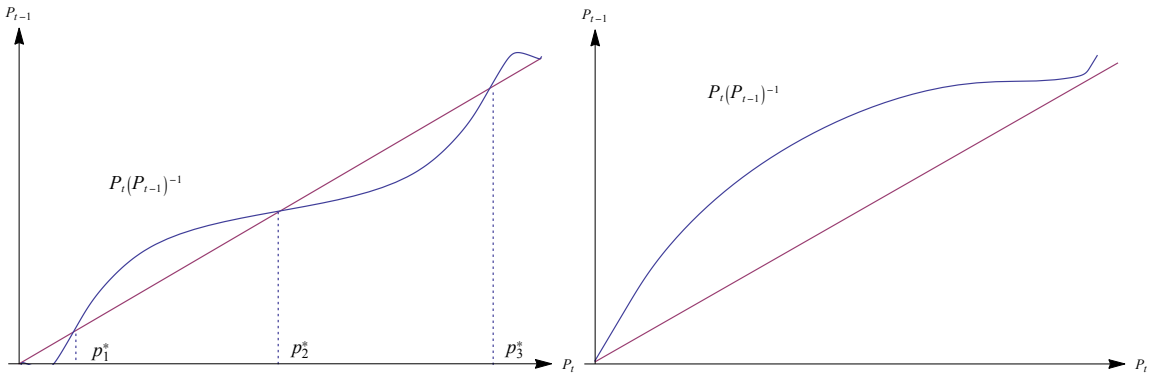

Figure 3.2: Illustration of possible equilibrium states with heterogeneous beliefs

$$P^* = \int_0^1 \left(1 - \int_0^{\hat{\pi}(a_i)} \theta(\pi)\, \mathrm{d}\pi\right) \cdot \phi(a)\, \mathrm{d}a \quad \text{with} \quad \theta(\pi) \sim (\Pi^*, \sigma) \tag{3.22}$$

The panels in Figure 3.2 again depict possible equilibrium states. They show the expected share of cooperators (P_t) as a function of average beliefs (Π_t) as derived in Equation 3.20. For illustrative purposes, beliefs are assumed to be approximately normally distributed. Again, this is the case when the individual's perception is determined by a number observations on randomly selected encounters.[13] The population coordinates on an equilibrium state when this period's expected share of cooperators equals last period's expected share indicated by an intersection with the 45° line. While in the first case - left hand panel - there are three possible interior equilibria including two stable ones, the right hand panel depicts a case where the only equilibrium emerges at $P_t = 0$ with a population which is entirely composed of non-cooperators.

The nature of emerging equilibria with heterogeneous beliefs is similar to the case in which beliefs are homogeneous. The reason is that the formation of beliefs is assumed to be independent of individual preferences. This is a reasonable assumption within the given setting if beliefs about the behavior of others are formed based on a number of

[13] In this way, beliefs will follow a binomial distribution. Assume that in each period, an individual receives information of n random situations of the described kind, where n is a positive but rather small number. Those observations will shape her perception of how many people would help in the situation described above. The individuals current π_{it} is then formed by her observations of the previous period. As n becomes large, information becomes finer and more accurate. Having a fraction of random encounters as basis for beliefs formation, it is sensible to assume that beliefs about the share of cooperative individuals in the population are not necessarily correct but correspond on average to the true fraction.

random observations of encounters. For both the baseline and the extended model, the equilibrium share of cooperators depend on the same factors.

Despite the tendency of individuals to conform to the behavior of others, there is the possibility of interior equilibria. This is the case when there are individuals with an altruistic trait close to the extreme values of one and zero who would always shirk ($\hat{\pi}(a_i) > 1$) or cooperate ($\hat{\pi}(a_i) \leq 0$). In this case only individuals with intermediate values of a ($0 < \hat{\pi}(a_i) < 1$) condition their behavior on their beliefs about the behavior of others. They are conditional cooperators.

Summary

The (expected) probability of receiving help in a population depends on several factors: it is (i) increasing in p_{t-1} and Π_t respectively, (ii) decreasing in the cost-benefit ratio $\frac{c}{b}$ and (iii) changing ambiguously in λ.

The results are intuitive:

> When individuals update their beliefs through information or by observing the behavior of others, the true probability of receiving help directly influences the beliefs arising in the next period. The higher the probability that an individual observed helping behavior in the preceding period, the higher on average will be the individual's believes of receiving help this period. Accordingly, the higher will be the average individual propensity that subject i will behave prosocially.
>
> Here, it is assumed that beliefs are based on information or observations of last period's encounters. However, there are also other sources of information that can influence beliefs and which can either bias beliefs systematically or randomly. Shocks which cause a high (low) level of generalized trust in a society results in a temporarily relatively high (low) level of cooperative behavior. This effect differs in its strength depending on the level of cooperation amongst the population and due to the reciprocity or norm effect. Systematically biased beliefs will consequently result in permanently higher or lower equilibrium levels of cooperation.
>
> A decrease of the cost-benefit ratio will increase the individual's inclination to help. The more individuals perceive the benefit of helping relative to the cost which helping creates to them, the lower will be the threshold parameter for cooperation.
>
> A change in the norm parameter λ has an ambiguous effect. When λ is low and hence relatively weak, individuals will mainly make decisions in accordance with their preferences and give little weight to the behavior of others. In this way, individuals with a relatively high level of altruism will decide to cooperate, while

those with a relatively low level will shirk. If the norm parameter gets stronger, this will induce some of the individuals with relative high level of a_i to stop cooperating, while some of those with relatively low level of a_i will cooperate. The overall effect of a change in the norm parameter therefore depends on how altruistic preferences are distributed.

3.5 Empirical analysis

While the aim of the preceding section was to formalize the link between trust and prosocial behavior, the focus is now on establishing an empirical relationship. The notion that people are affected in their behavior by their beliefs about the behavior of others is crucial to the results of the model presented. Due to the restricted availability of information, beliefs about others' behavior in a specific situation are substituted for the wider notion of expectations namely, generalized trust - based on the standard trust survey question. The question thus remains: do we observe changes in behavior when individuals change their level of generalized trust? In view of data limitations, here the empirical analysis is not conducted at the individual level but at an aggregate (state) level. I analyze how variations over time and space in the level of generalized trust influence people's willingness to donate blood to the German Red Cross. A number of control variables are used, amongst them measures for the perceived benefit of a blood donation, the number of blood donation sites organized by the Red Cross and other economic factors.

Blood donation is often referred to as one of the purest examples of altruistic or prosocial behavior (Healy (2000)). The choice of the blood collector is highly relevant for any analysis of blood donations in Germany. Blood donations are collected mainly by the Red Cross, hospitals and community blood banks. The German Red Cross is the biggest blood collector in Germany with an annual 3.57 million examples of blood donations and a market share for blood products of about 75 % (Deutsches Rotes Kreuz e.V. (2012)). It should also be noted that the German Red Cross does not pay donors for their contribution. The majority of blood donations are collected through mobile blood donation sites. Those mobile facilities are usually installed to be clearly visible on public squares or in public buildings such as schools or community centers.[14]

At first glance, the case of blood donations does not seem very applicable to the encounters of strangers analyzed in Section 3.3 and 3.4. Yet, when considering the nature of the decision - a purely non-strategic, transient interaction between strangers where

[14]There are on average 200 mobile blood donation sites in the field throughout Germany per day. More information on blood collection of the German Red Cross can be found at http://www.drk-blutspende.de/blutspendedienste/drk-blutspendedienste.php.

Table 3.1: Variable Definition and summary statistics

Variable	Variation	Mean	St. Dev.	Min.	Maximum
Yearly Number of first-time donors (state-level, per 10 000 inhabitants aged 18 to 60)[A]	overall	66.327	21.961	29.210	107.057
	between		21.495	38.436	96.304
	within		7.613	49.701	81.919
Yearly Number of blood donations of repeat donors (state-level, per 10 000 inhabitants aged 18 to 60)[A]	overall	720.4844	245.4711	175.6581	1213.769
	between		250.554	227.694	1113.98
	within		51.021	583.071	857.038
Yearly number of accidents (count of ' 'accident' ' in regional newspaper)[B]	overall	0.741	0.198	0.235	1
	between		0.104	0.527	0.884
	within		0.170	0.273	1.137
Level of generalized trust (Share of people who disagree with the statement "Most people don't really care what happens to the next fellow' ' (yearly, state level)[C]	overall	0.240	0.051	0.125	0.375
	between		0.037	0.183	0.291
	within		0.036	0.162	0.327
Number of mobile blood donation opportunities (number of' 'Blood drives' ')[B]	overall	3.313	1.646	1.24	6.68
	between		1.674	1.475	5.983
	within		.371	2.467	4.214
Average yearly unemployment rate (state-level)[D]	overall	13.472	5.487	4.6	22.1
	between		5.164	6.02	18.48
	within		2.370	8.732	17.092
Yearly per-capita GDP (state-level)[D]	overall	39.098	9.709	26.723	58.606
	between		9.605	30.264	54.096
	within		3.087	33.679	43.608
Yearly case number of notifiable infectious and parasitic diseases among 15 to 60 year olds (state-level, per 10 0000 inhabitants aged 15 to 60)[D]	overall	2.64	0.356	1.987	3.558
	between		0.239	2.271	2.940
	within		0.273	2.140	3.416

Notes: *Data source:* [A] German Red Cross, [B] own calculations based on information of the online archives of Schwäbische Zeitung, Münchener Merkur, Berliner Zeitung, Märkische Allgemeine Zeitung, Frankfurter Allgemeine Zeitung, Ostsee Zeitung, Neue Osnabrücker Zeitung, Mitteldeutsche Zeitung, [C] German General Social Survey (ALLBUS); the used sample is restricted to observations with answers "I agree" or "I do not agree"; it does not include observations with missing answers or the answer "I don't know" [D] Federal Statistical Office Germany (Employment Agency, Regional Accounts, Hospital statistics); The number of cases is related to the population aged 15 to 60. The deviation from the age group of potential donors arises out of the age group categories for which the hospital data is released.

individuals have no ability to identify their counterpart - donating blood to an anonymous person is more akin to the encounter in question than actual pairwise interactions. Due to the institutionalized process of donating blood, there is hardly any social or material reward. The relation between donor and recipient remains very abstract and transitory. As a consequence, the literature on donor motivation has identified altruism, enhancing self-esteem, perceived community need for blood and reciprocity as common motivations (Bednall and Bove (2011)). Another difference to the setting in Sections 3.3 and 3.4 is that individuals are not directly asked to donate but need to motivate themselves. However, awareness of the value of blood and its scarcity is generally high in the population. In this sense, having a blood donation truck on a public square or a notification on a public building are both means of making an indirect request of each passing person to donate.

In spite of the existence of relatively minor drawbacks, there are several clear advantages to using data on blood donation in preference to other forms of donations. Firstly, the donation infrastructure in Germany is well established and has not changed significantly in the past 10 years, so facilitating the process of giving donations for newly motivated donors. Small changes in the cost-benefit-ratio or the level of generalized trust are more likely to result in an increase of donations in comparison to other donation areas where the donation infrastructure is less well-known. Secondly, an individual's blood donation is not a perfect substitute for another individual's donation. Several factors including the blood group and predispositions, are required for finding a matching blood donor. These factors along with the personal nature of donation serve to reduce possible crowding out effects.

Previous studies on blood donation behavior focused mainly on the individual characteristics of donors. Although recognized to be important, measures of social capital are rarely included. Healy (2000) uses regular volunteering as an indicator for social capital but finds no significant relationship between the two. A few studies analyze the determinants of blood donations at a macro level. They analyze the relevance of regional differences like economic indicators (unemployment rate, average income) and the composition of the population (age structure, the proportion of university graduates) for the number of collected donations. Some also include in their analysis institutional trust, measured by voter turnout (Weidmann et al. (2012); Bekkers and Veldhuizen (2008)) and the different institutional settings of blood collection (Healy (2000)). Differences in voting behavior are found to be strongly related to variations in blood donations between municipalities. Healy (2000) analyzes different blood donation regimes that can be categorized as state-run systems, systems with a monopoly of blood banks and systems with a monopoly of the Red Cross. The results suggest that the composition of donor groups changes according to the blood collection regime. In countries where the Red Cross has a monopoly on collection, the share of blood donated by repeat and regular donors is distinctively higher than in state-run systems or systems dominated by blood banks. Healy (2000) also finds differences in socioeconomic characteristics of

donors between regimes. Therefore, the results found here may only apply to a limited extent to other countries.

In the analysis, I use variations by state and over time in the level of trust as well as in the perceived benefit of a blood donation to see how both affect aggregate blood donation behavior. I employ data on different German states over several years. To analyze the relationship between the variables of interest, I use a state-fixed effects regression model. The fixed effects capture differences in the level of donations between states which are caused by factors which are relatively time-constant like age structure, compositional differences, the presence of other blood collectors than the Red Cross and the number of fixed donation sites. I further distinguish between the number of blood donations by regular or repeated donors and the number of first-time donors. My hypotheses arise from the theoretical model. Both the level of generalized trust in a population and the perceived benefit of a donation are expected to be positively related to the number of blood donations. Yet, the effect is expected to differ between donations of repeat donors and first-time donors. I hypothesize that it is principally the behavior of first-time donors which is affected by small changes in the variables under discussion.

For the German Red Cross, most of the blood donations are collected from a stock of repeat donors. The stock decreases by a certain number of individuals who no longer qualify for donating blood every year while, at the same time, the stock is refreshed by a number of new donors. If there are no major changes in cohorts between years, then the number of first-time donors should be relatively constant. However, according to the model, the number can change due to variations in the level of generalized trust, a change of the perceived cost benefit ratio, changes to the norm sensitivity or changes in the distribution of altruistic preferences in the population. The last two elements are difficult to measure and subject to substantial inertia, meaning that they cannot be examined in the analysis. Generalized trust and the cost-benefit-ratio, however, vary sufficiently over time. Both affect the behavior of conditional cooperatively behaving individuals. In regard to the distinction between donations of first-time donors and repeat donors, I expect the effect to be stronger for the number of first-time donors. Being that the share of conditional cooperators should be higher among first-time donors, their decision should thus be influenced to a much greater degree by changes in the cost-benefit- ratio or the level of generalized trust. I also include a lagged value of the number of total blood donations and the number of yearly mobile blood donation opportunities. The latter increase the opportunities to donate blood, which may have a significant effect on repeat donors but only a minor effect on first time donors because it leaves unchanged incentives to behave cooperatively. The lagged amount of collected blood donations is supposed to capture both changes in the beliefs about the willingness to donate blood by other members of the population as well as changes in the stock of repeatedly contributing donors. It is therefore expected to influence both the number of first-time donors as well as the donations of repeat donors.

To measure trust, I use data from the German General Social Survey (ALLBUS). The ALLBUS is a biennially conducted survey on attitudes, behavior and social structure in Germany. Each wave is a nationally representative survey of the population aged 18 and above. The data used in this paper comes from the 2002, 2004, 2006, 2008, 2010 ALLBUS surveys. The standard trust question ("Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people") is included in the survey for only a few years. I therefore use the following question: "Die meisten Leute kümmern sich in Wirklichkeit gar nicht darum, was mit ihren Mitmenschen geschieht" (Most people don't really care what happens to others) with the answer options "Bin derselben Meinung" (I agree), "Bin anderer Meinung" (I disagree), and "Ich weiß nicht" (I don't know). I assume that the respondent's evaluation of the statement reflects her level of generalized trust and refers to π_{it} in Section 3.4. I use the reported trust measure to determine regional averages for all the years available. For the perceived benefit of blood donations, I use the report of accidents in regional daily newspapers.[15] As blood donations are often used for emergency cases, the count of the word "accidents" is assumed to approximate the demand for blood products as perceived by the population.

Table 3.1 gives an overview over the variables used in the analysis and their descriptive statistics. To account for variations in the number of blood donations which is not driven by changes in the regional level of generalized trust or the perceived benefit, I control, amongst others, for variation of blood donation opportunities, variations in notifiable infectious and parasitic disease cases, and variations in the unemployment rate and per capita GDP and include time fixed effects. The blood donation measures and the notifiable infectious and parasitic disease cases are not expressed in absolute numbers but are relative to the approximated number of potential donors living in the respective state. I use data on ten German Bundesländer[16] for the years 2004, 2006, 2008, 2010. For five of the Bundesländer, data on blood donations for 2002 is available and also

[15] I count how often the word 'Unfall' (accident) appears in newspaper articles per year. I only use online archives to determine the number. Unfortunately, the scope of articles in the online archives varies over years. Especially for the years of the early 2000s, articles for only part of the year or only selective ones can be found in the online archives. I therefore relate the count of 'Unfall' to the count of 'und' (and) - a word whose appearance in the online archives I assume to be uncorrelated with the selection of articles which are available in online archives and uncorrelated with the count of accident. To account for partly substantial differences in comprehensiveness of online archives between different newspapers, I standardize the measure for each newspaper. I assign the value 1 to the year with the highest count for each newspaper and express all other counts as shares of the highest count. In the case of Hessen, Sachsen and Thüringen, the regional daily newspapers did not have online archives that allowed access to articles for the entire period of the analysis. I used information from the Frankfurter Allgemeine instead - one of the trans-regional German newspapers with the highest circulation.

[16] Baden-Württemberg, Bayern, Berlin, Brandenburg, Hessen, Mecklneburg-Vorpommern, Niedersachsen, Sachsen, Sachsen-Anhalt, Thüringen

included in the analysis. The estimates are determined by using a log linear model with the following specification:

$$D_{st} = \alpha_s + \beta_1 B_{st} + \beta_2 T_{st} + \beta_3 BD_{t-1} + \beta_4 X_{st} + \beta_4 Y_t + \epsilon_{st}$$

where D_{st} represents the natural logarithm of a measure of blood donations in state s at time t, α_s are fixed effects which control for unobserved time-invariant state factors that affect the number of blood donations, B_{st} is the natural logarithm of a measurement for the benefit of donating blood, T_{st} is the natural logarithm of a measure of social trust, BD_{t-1} is the number of total blood donations (blood donations from first-time as well as regular donors) in year $t-1$, X_{st} is a vector of K exogenous control variables for state s at time t, Y_t is a vector of year fixed effects and ϵ_{st} is the contemporaneous error term.

Table 3.2 presents the results of the state fixed effects estimation. The most interesting aspect of the results are the effects of the variables that are expected to affect the willingness to donate blood. These are the coefficients of generalized trust and the measure of the perceived benefit of donating blood i.e. the appearance of the word accident in regional newspapers. The results show clear differences in the effects for the number of first-time donors and the number of donations by repeat donors. As expected, the variables influence the number of newly motivated individuals more than the pool of repeat donors. The number of first-time donors is positively related to the level of generalized trust in a population and the perceived benefit of the blood donation while the effects are not significant for repeat donors. The coefficient of generalized trust decreases when the lagged value of total number of whole blood donations is included for regressions on both dependent variables but remains significant at a conventional significance level for the number of first-time donors. This indicates that some of the correlation between generalized trust and the number of first-time donors may be induced by donation behavior of the previous period. In the model, those two variables are (on average) equal. The source of information, however, that is used to form expectations measured with the generalized trust variable is much broader and does not merely rely on the number of last year's donations. It is therefore not surprising that the correlation of the two variables is positive but not significant. While the coefficient of the lagged value is not significant for the number of first-time donors, it is highly significant for the number of blood donations by repeat donors. The lagged number of total blood donations indicate changes in the stock of repeatedly contributing donors. The number of last year's donations increases the explained variation of this year's number of donations of repeat donors by 16 percentage points. The strong correlation of those two variables may be due to a relatively high number of regular donors in the pool of donors.

Another interesting result is the varying significance of the coefficient for the variable indicating the number of donation opportunities. The coefficient is insignificant for the number of first-time donors and highly significant for the number of donations by repeat

Table 3.2: Fixed effects estimation of the level of social trust and perceived benefit of donating blood on measures of blood donations

Dependent variable	Number of first-time donors			Number of blood donations		
Independent variables	(4)	(5)	(6)	(7)	(8)	(9)
Generalized trust		0.342*	0.290*		0.102	0.012
		(0.171)	(0.170)		(0.122)	(0.087)
Blood donations (t-1)			0.326			0.570***
			(0.215)			(0.110)
'Accidents'	0.240**	0.279***	0.262***	0.089	0.100	0.070
	(0.098)	(0.095)	(0.093)	(0.066)	(0.068)	(0.048)
Donation opportunities	0.329	0.233	0.034	0.610***	0.582***	0.233*
	(0.200)	(0.195)	(0.231)	(0.134)	(0.139)	(0.118)
Unemployment rate	0.663	1.087**	1.067**	0.002	0.128	0.093
	(0.401)	(0.435)	(0.424)	(0.269)	(0.309)	(0.217)
Per capita GDP	0.921	1.507	1.014	4.095***	4.270***	3.409***
	(1.859)	(1.784)	(1.769)	(1.245)	(1.269)	(0.904)
Infectious diseases	0.519	1.121	1.163	−0.192	−0.012	0.061
	(0.773)	(0.792)	(0.772)	(0.518)	(0.563)	(0.395)
Observations	45	45	45	45	45	45
R^2	0.442	0.519	0.561	0.691	0.699	0.858
p-value	0.027	0.011	0.009	0.000	0.000	0.000

Notes: All variables are in logs. Corresponding standard errors are reported in parentheses. Not displayed: year fixed effects, * indicates $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Data source:* see table 3.1.

donors. The higher the number of donation opportunities, the higher is the number of people who can be reached and the higher the number of occasions for donating per individual. Hence, the incentive to donate does not change but it provides more opportunities to those who want to donate. The opportunities to donate blood to the Red Cross are already at a relatively high level and will reach a lot of people. Therefore, increasing the frequency or spatial density has no significant effect on the number of first-time donors but increase the number of blood donations in total.

There is a positive effect of the level of unemployment on the number of first time donors, but no effect on the number of blood donations of repeat donors. According to the model, this trend might be due to the decreasing relative costs of donating blood

which increases the incentives to donate blood. The effect is therefore stronger for first-time donors than repeat donors. The coefficients of per capita GPD also show a strong difference between the two groups of donors. The effect is only significant for repeat donors. This positive effect on the number of donations of repeat donors might be something particular to the German Red Cross, whose marketing is mainly funded by donations and the voluntary contributions of firms and associations. A higher level of GDP might therefore be correlated with a higher level of marketing and, subsequently, by a higher number of donations.

It should be noted that this empirical analysis has clear limitations in explaining the behavior of individuals. Inferences about the behavior at the individual level cannot easily be deduced from inferences of aggregate behavior. Hence the analysis cannot confirm the ascribed individual behavior, yet it supports the afore-mentioned link derived between beliefs and the willingness to behave prosocially. The experimental literature discussed in Section 2 further corroborates the fact that variations in prosocial behavior at the aggregate level might indeed be managed by beliefs.

3.6 Concluding remarks

Encounters with strangers constitute an increasingly large proportion of our everyday social interactions. We are interacting with people who we do not know, to whom we are not linked by any obligation or affection and thus to whom we owe nothing. Still, we are frequently engaging in behavior that is costly and mainly benefits a stranger.

As shown in many economic lab experiments, individuals are more likely to behave cooperatively when they think others do so as well. In the model presented here, trusting individuals are more likely to engage with strangers and thus enable beneficial course of actions. It is assumed that individuals are not predetermined to adopt a certain behavior. It is rather that individuals - who are endowed with altruistic or selfish preferences - select their behavior rationally given their preferences and their beliefs. This fact gives rise to conditional cooperators who base their decision to help on the behavior of others. By adjusting the behavior to that of others, a high level of generalized trust in a society promotes a relatively high level of cooperative behavior, even among strangers. Thus, findings of empirical studies relate generalized trust to different economic phenomenons (e.g. Knack and Keefer (1997); La Porta et al. (1997)).

Another factor that facilitates cooperative behavior is the perception of the benefit of behaving cooperatively. The more an individual perceives the benefit of her action the more likely she is to behave cooperatively. This occurrence has certain policy implications. In situations where formal contracts are limited or too onerous and personal

relations are not possible, information on the positive behavior of others may help to improve cooperation by correcting exceedingly pessimistic beliefs. The empirical evidence of this work and of other studies also suggests a more subtle notion of expectations about the behavior of others; namely, that generalized trust is related to prosocial or cooperative behavior.

I am convinced that this lesson applies to many other areas. Thus, any policy measure that promotes generalized trust constitutes a potentially important policy instrument. In addition, making people more aware of the benefit of their behavior may promote prosocial behavior.

4 Choices, beliefs and trust dynamics

Abstract

Research on social dilemmas has emerged from a wide range of disciplines over a number of decades. Yet, several observed patterns of cooperative behavior remain inadequately understood. These include the difference in cooperative behavior between rural and urban areas. The aim of this paper is to outline a (possible) micro-structure and conditions which lead to the observed urban-rural differences in macro behavior using agent-based modeling. The model presented here adapts the familiar framework of a prisoner's dilemma which is played repeatedly with randomly matched members of a large population. I introduce features which are often found in real world interactions: imperfect information, voluntary participation and a taste to conform to majority behavior. In this analysis peoples' beliefs about the level of cooperation in the population and their corresponding behavior are determined endogenously. Both of them are governed principally by the experience that individuals have derived from interactions. I present results of an agent-based simulation in order to study emerging, dynamic relationships and examine how cooperative behavior evolves over time and under different circumstances. I also examine how urban-rural differences in behavior emerge. The factors that give rise to rural-urban differences include heterogeneity in loss aversion or risk taking, and limited possibilities of migration between rural and urban areas.

JEL: D03 D64 D83
Keywords: social dilemma, trust, voluntary participation, agent-based models

4.1 Introduction

This study analyzes spontaneous cooperative and helping behavior directed at strangers or so-called out-group members. Although scholars from a wide range of disciplines have analyzed this phenomenon, some issues are still puzzling to researchers, notably those emerging from observations of everyday life in anonymous environments. Besides recognition of the phenomenon that cooperation can take place at all in anonymous environments, it is recognized that this kind of spontaneous helping or cooperative behavior is found to be more frequent in rural than in urban environments. This is not merely conventional wisdom, as it has been previously demonstrated by a number of empirical studies using different measures of prosocial behavior, such as willingness to give back over-paid money (Korte and Kerr (1975)), to respond to survey questions (House and Wolf (1978)), to agree to a request to change money (Korte and Ayvalioglu (1981)) or to offer help to a person who fell on the sidewalk (Amato (1983)). Those studies mainly conclude that high levels of urbanization are in correlation with a low level of prosocial behavior.

Expectations about the willingness to help of others have proven to be important in this context. Many empirical and experimental studies have shown that individuals often behave cooperatively only conditionally.[1] That is to say that helping or cooperative behavior is closely related to the expectation of receiving help or reciprocated cooperation. Difference in beliefs about the level of cooperativeness of strangers has been less well studied in the rural-urban context, although there is some evidence that the level of trust in strangers is higher in rural than in urban areas (e.g. Onyx and Bullen (2000)).

The observed differences in prosocial behavior are in part due to compositional effects as those differences in behavior are accompanied by socioeconomic and sociodemographic disparities.[2] In addition these differences are hypothesized to emerge due to differences in the nature of social interactions compounded by differences in the structure of interpersonal ties in rural and urban environments. Interactions in rural areas are often thought to be embedded in networks of personal ties while interactions in urban areas are said to be impersonal and transitory (Hofferth and Iceland (1998)). These patterns are a direct consequence of the physical and social structure of rural environments. Rural areas are characterized by low population density and less developed infrastructure. Such a characterization has two immediate effects. Firstly, dispersion and distance restrict the opportunities for contact with unrelated individuals or strangers, meaning that social interactions are necessarily embedded in networks of personal ties. On the other hand, isolation, lack of public transport and the reduced availability of public services in rural areas increase the need for building up networks for cooperation in rural

[1] e.g. helping strangers (Fjneman et al. (1996)), when using common pool resources (Schultz et al. (2007)).

[2] Not all of the above mentioned studies account for these differences.

environments. Beggs et al. (1996) show that personal networks in rural areas are much denser than personal networks in urban environments. That is, ties prove to be of greater intensity and are more based on kinship and neighborhood solidarity in the networks of rural areas, in contrasting to networks in urban areas which are larger, more dispersed and more based on friendship i.e. members are less interconnected.[3]

If rural-urban difference in prosocial behavior directed at strangers is due to a higher dependency on cooperation or a more traditional way of living in rural areas, there should be also be an observable difference in in-group behavior. Yet, rural-urban differences in prosocial behavior seem to be limited to interactions that are directed at strangers. When interacting with related individuals, these differences in behavior are less pronounced. Amato (1993) finds no significant rural-urban difference when comparing helping behavior that is directed towards close others, i.e. to family members, relatives and friends. Similarly, Hofferth and Iceland (1998) find that rural-urban differences are rather small in patterns of exchange among relatives. However, their results also show that families living in rural environments are more likely to exchange exclusively with relatives in comparison to families living in urban environments. Social interactions take place more often in social networks in rural areas while urban interactions take place more often between strangers. Hence, the conditions of interactions with strangers differ between rural and urban areas.

I follow this line of thinking and outline a possible framework for decision-making in rural and urban contexts. The theoretical foundation of rural-urban differences in prosocial behavior has received little attention in previous studies. The aim of this paper is to outline micro behavior and specific conditions which lead to the observed macro patterns of rural-urban differences in levels of trust and consequently cooperative behavior. Previous research suggested that differences might arise due to (i) the different nature of interactions, (ii) differences in the composition of the population and (iii) differences in beliefs about the behavior of others. Beliefs are clearly shaped by experience and information.

Meeting a defecting agent causes a loss for an agent. Engaging voluntarily in social interactions therefore implies a certain level of trust in the cooperativeness of other agents. Yet, urban agents are not able to restrain from interactions with strangers even when their level of trust is below this threshold of trust that is necessary to have the perception of beneficial encounters with strangers. A relatively low level of cooperation in the population will then cause urban agents to revise further downwards their level of trust while rural population can avoid encounters with strangers. If information is incomplete and beliefs mainly based on experience, the consequence may be a variation

[3]Beggs et al. (1996) find further differences in the composition of the networks. Networks in rural settings are more homogenous with regard to education, ethnicity and religion of network members than networks in urban areas but less homogenous respect to age and gender.

in expectations about the cooperativeness of strangers in rural and urban environments, and hence differences in cooperative behavior.

This work formalizes the afore-mentioned relationship and analyzes it using agent-based modeling and simulation.[4] The central assumption is that individuals change their beliefs and therefore their behavior according to experience derived from encounters. The interdependent behavior of agents and the endogenous determination of beliefs through the experience of encounters are difficult to trace deductively. In the related literature, the standard assumption is therefore often that those beliefs are exogenous to the individual and correct in equilibrium. The impact that an endogenous determination of beliefs has on the aggregate cooperative behavior might be substantial. Agent-based simulation provides a framework for the investigation of aggregate behavior of a large number of agents who repeatedly engage in strategic interactions and who are able to learn from their experience.

In trying to explain the observed macro patterns, this article faces two problems: (i) what facilitates a stable level of cooperation among strangers in anonymous environments and (ii) what induces differences in behavior and trust between rural and urban areas. The first problem arises because the self-interested rational choice is by definition defection in social dilemmas. Yet, the rate of cooperation is commonly between 40 and 60 % in one-shot prisoner's dilemma games (Fehr and Fischbacher (2002)). Theoretical and empirical research motivated by this kind of observation suggest that individuals exhibit other-regarding preferences which change the net incentive structure of the moves and thus allow for cooperation as a rational choice. To model the occurrence of cooperation, I use stylized facts from field and lab experiments which suggest that individuals tend to compare their behavior to the behavior of others and tend to conform to the behavior of the majority.[5] In regard to the second problem there is, to the best of my knowledge, no theoretical research and only a small quantity of empirical research available so far. This issue constitutes the main problem of this study. The hypothesis derived from the empirical evidence cited above states that the number of interactions with strangers may be related to the difference in beliefs and therefore in behavior. Consequently, the model will include different restrictions for the number of interactions between rural and urban areas.

In the following, I report results of simulations of simultaneous prisoner's dilemma type of situations which outline a possible solution to the puzzle of why there are differ-

[4] Besides deduction and induction, agent-based modeling is a third kind of research methodology for investigating individual behavior and its consequences. Like theoretical studies, agent-based models start with a set of well-defined assumptions. While assumptions may be clear and rather simple, the consequences may not be obvious. In addition, an agent-based model is capable to reveal consequences of those assumptions through simulation that cannot be deduced with standard mathematical techniques. For Axelrod, simulation is therefore a way of doing thought experiments (Axelrod (2000)).

[5] Theoretical and experimental research also suggest that the first problem can be explained by social preferences like altruism, inequality aversion and similar preference types.

ent levels of trust and cooperation between strangers in rural and urban areas. Central factors that explain a stable level of cooperation in the population include a taste for conformity and the possibility of avoiding interactions to some extent. The taste for conformity is the behavioral pattern that facilitates cooperative behavior in a way that enables cooperation to be not always dominated by defection. For high levels of cooperation in the population, cooperative behavior may turn out to be the favorable strategy. Voluntary participation, i.e. the option not to play, is the mechanism which facilitates a stable level of cooperative behavior in the population. Without voluntary participation, cooperation is not stable and will be likely to eventually disappear. Rural-urban differences in trust then occur due to different restrictions for voluntary participation.

Voluntary participation has often been neglected in modeling interactions between individuals. The link between beliefs and voluntary participation is the experience that is derived from encounters. For rural-urban differences to be persistent, I additionally need to assume heterogeneity in preferences for encounters with strangers. Agents with lower loss aversion tend to sort into urban areas more often than into rural areas. I then find that rural-urban differences - as they are found empirically - depend decisively on one structural condition: the limited nature of migration between rural and urban areas.

The next chapter reviews selected literature concerning two central aspects of the model: conformity behavior and voluntary participation in games. The third section describes the model and its properties while the subsequent section explores the dynamic effects expected and the steady state properties of the model. In Section 5 the simulation is outlined and its results presented. In the last section, the results are discussed and some concluding remarks are offered.

4.2 Literature

For decades, social dilemmas have been a fascinating topic of research for scholars from a wide range of disciplines and the quantity of theoretical as well as empirical studies is enormous. The following overview can therefore only be a selected survey of the relevant literature. Fundamental to social dilemmas is the conflict between the behavior that is good for the individual actor in the short run, and the kind of behavior that is beneficial for the society or group in the long run. This conflict becomes particularly clear when individuals are confronted by social dilemmas in anonymous environments. Reward and punishment will not work here because the probability of meeting the same agent again is sufficiently low. The agent cannot rely on future benefits coming from her cooperative behavior - a condition which promotes non-cooperative behavior. Consequently, classical game theory shows that in social dilemmas in which individuals face unrelated individuals, defection is the dominant strategy. In everyday life, however, we often see that social dilemmas are overcome with cooperation achieved, despite the fact that coop-

eration is dominated. Even in the artificial environment of an experimental laboratory where the complexity of a social dilemma is strongly reduced and consequences are easily conceivable, we find a substantial amount of cooperation in one-shot situations that are completely anonymous.[6] To explain a persistent level of cooperation between strangers in the population, I use two widely observed phenomena to model the decision-making that takes place in social dilemmas. That is, individuals engage differently often in social interactions and they compare their behavior to that of others and tend to conform to the behavior they observe.

4.2.1 Conformity

Economists have recognized the prevalence of conformity in decision-making. Depending on the context, conforming behavior arises mainly through the following channels: (i) individuals learn from the experience of others, (ii) they comply to a (descriptive) norm and (iii) they reciprocate the behavior of others. The main difference is the underlying motivation that induces conforming behavior. The first case requires that there is imperfect information, or at least the individual perception of lacking important information for decision-making. The choice of others then serves as a signal for the quality of the choice. This process is often referred to as rational imitation or information cascades (Banerjee (1992); Bikhchandani et al. (1992)). Through social learning derived from experience of the behavior of others, individuals try to determine the most effective choice; that is, the one that maximizes their material well-being. The benefit of complying to a norm or reciprocating others' behavior is not necessarily motivated by increasing material gains. The utility gain of complying to a descriptive norm can have manifold, often interrelated motivations while the underlying process does not seem to be clear. The economic and social psychology literature suggests that, among others, individuals adjust their behavior because they may have a desire to behave correctly in order to avoid punishment or a loss in reputation. Other reasons for adjusting their behavior are that they derive utility from maintaining a positive self-image, they want to generate a feeling of similarity that enhances social identification and they have a preference for reciprocity or fairness (Deutsch and Gerard (1955); Cialdini and Goldstein (2004); Schultz et al. (2007); Irwin and Simpson (2013)). In contrast to social learning, the change of behavior through complying to a descriptive norm does not need to be driven by the desire to directly improve the material well-being, but rather to increase a non-material value. However, image-related concerns or reciprocating behavior may refer to future material consequences (Trivers (1971); Nowak and Sigmund (1998)). Conforming behavior is especially strong when deviation from the socially desired behavior can be directly or indirectly observed and punished.

[6] e.g. Cooper et al. (1996) with cooperation rates greater than 20 %, in the initial periods even averaging 38 %, Andreoni and Miller (1993) find rates between between 7 and 28 %.

When analyzing a social dilemma situation involving anonymous one-shot interactions, neither image-related concerns nor social learning are relevant. I have therefore decided to concentrate upon the literature on social comparison in cases where conforming behavior is largely irrelevant for the material pay-off. Social comparison, and subsequent conforming behavior, have been shown in various economic lab experiments with public goods, dictator and prisoner's dilemma games (e.g. see Cason and Mui (1998); Bardsley and Sausgruber (2005); Krupka and Weber (2009); Bicchieri and Xiao (2009); Zafar (2011)). However, there have also been cases analyzed in a number of field experiment settings (e.g. Frey and Meier (2004a); Landry et al. (2006); Croson and Shang (2008); Shang and Croson (2009) for field experiments on charitable giving). All these studies find that when individuals receive information about the actions of others they tend to adjust their behavior to that of others. The effect is even greater when individuals are observed by others; here, image-related concerns may arise as a consequence. Yet, the effect of social information is also found in strictly payoff independent situations e.g. one-shot anonymous dictator games or field experiments on charitable giving (see for example Krupka and Weber (2009); Bicchieri and Xiao (2009); Frey and Meier (2004a); Landry et al. (2006); Croson and Shang (2008); Shang and Croson (2009)). In absence of any information, the individual's choice is correlated with the belief about the choice of others. Individuals also tend to adjust their behavior to that of others even when situations are non-strategic and there are no obvious sanctions for not following. These outcomes illustrate the scope of situations to which conforming behavior applies.

The idea of incorporating social comparison and conforming behavior into models of decision making is not new, though it is seldom applied.[7] Existing models mostly assume some kind of "psychic cost" from deviations of social customs or descriptive norms. The degree of the loss from not complying depends often either on the extent to which an individual's action differs from those chosen by others, or on the number of agents who comply with them. Naturally, this psychic cost generates some convergence of choice.

4.2.2 Voluntary participation

The evolutionary stable emergence of cooperation amongst unrelated individuals is still inadequately understood. A substantial amount of work has been devoted to identifying conditions and mechanisms under which cooperation can evolve in social dilemmas. One way to obtain a persistent positive level of cooperation is to make participation voluntary rather than obligatory. The option not to play is often a neglected feature of game theory dealing with social dilemmas. It facilitates cooperation if it is the best response

[7] In economics, a taste for conformism in a wider sense has been assumed for example to study phenomena such as following social customs (Akerlof (1980)), work effort (Levine (1992); Bratsiotis and Peng (2008)), cooperation generally (Mengel (2009); Traxler and Spichtig (2011)), tax compliance (Myles and Naylor (1996); Traxler (2010)), tipping (Azar (2004)) and voting (Coleman (2004)).

to defection (or being exploited). It is well understood that voluntary participation can facilitate cooperation when individuals are able to discriminate between more or less cooperative opponents. Being that an interaction only takes place if both players mutually agree to it, such a distinction enables individuals to avoid exploitation by defectors.

Orbell and Dawes (1991) and Macy and Skvoretz (1998) were the first to model one-shot prisoner's dilemma with the option to refuse to play, in a situation which do not rely on the cooperators capacity to recognize other cooperators. Orbell and Dawes (1991) instead assumed that individuals tend to project their own intentions onto prospective partners. In this way, a higher share of cooperators participate in interactions than there are in the overall population (it evolves a "cooperator's advantage"), as cooperators are less suspicious in encounters with strangers than defectors, and thus less inclined to exit games. Macy and Skvoretz (1998) take up the idea of voluntary participation and place it into a network context. When agents interact with their neighbors, effective norms for trusting strangers emerge locally. These norms then diffuse to interactions with outsiders. Szabó and Hauert (2002a) propose a prisoner's dilemma game in which a risk-averse loner strategy is introduced. Loners refuse to interact with the opponent and rely instead on a small but fixed income. However, for cooperation to be persistent in a population, interactions need to be spatially structured i.e. each player interacts only with her neighbors. The strategy of non-participation causes the cyclical dominance of strategies, providing a way out of mutual defection and so causes local clusters of cooperation. Beraldo and Sugden (2010) present a prisoner's dilemma game with voluntary participation of anonymous one-shot interactions where players are matched randomly. They demonstrate that cooperation is facilitated by voluntary participation in interaction with stochastic payoffs. The stochastic payoffs thereby allow for the possibility that cooperation yields a higher pay-off than defection.

Similar to the literature on prisoner's dilemmas, voluntary participation has been shown to be an effective way to overcome the tragedy of the commons in public good games (Hauert et al. (2002b); Szabó and Hauert (2002b); Hauert et al. (2002a)). These models introduced also a loner strategy. Introducing non-participation as a third strategy causes strategies to become intransitive in dominance (cooperation is dominated by defection which is dominated by non-participation which is dominated by cooperation), so causing cyclical dominance of strategies. While Hauert et al. (2002b) and Szabó and Hauert (2002a) show this for structured populations, Hauert et al. (2002a) presents results for a fully mixed population. Nonetheless, this result cannot be transferred to pair-wise interactions as they invariably lead to pure strategy equilibrium where only loners occur.

The option not to play was also analyzed in laboratory experiments. Orbell et al. (1984) introduced the first experimental setting with voluntary participation in a social dilemma. The game played was a one-shot n-player prisoner's dilemma game in

which the authors first elicited the participants' strategy choice (cooperate/defect) and subsequently their participation choice (enter/exit the game).[8] Against their intuition, cooperators tended to be proportionally less likely to leave the game than defectors. The researchers hypothesized that cooperators leave the group less often for the same ethical or group-regarding consideration; those which led them to cooperate in the first place. This decision causes a self-selection of cooperators into the game thereby increasing the level of cooperation. Orbell and Dawes (1993) conduct a one-shot two-player prisoner's dilemma game, with and without voluntary participation. They find that the option not to play increases the level of cooperative interactions. The authors speculate on the reasons for this phenomenon. They argue that trust in the partner's intention to cooperate and their own trustworthiness may have been "jointly selected as the emotional motivators supporting cooperators' willingness to enter prisoner's Dilemma relationships" (Orbell and Dawes (1993), p. 798). As an alternative explanation, they suggest that individuals project their own intentions on others which is compatible with the "false consensus effect" (Ross et al. (1977)). Hauk (2003) presents an experimental study whose formal setting is very similar to the game environment presented here. In her game experiment, participants play multiple prisoner's dilemma games simultaneously but face an "attractive outside option" (the payoff which exiting the game yields is higher than the payoff from mutual defection). Similar to the afore-mentioned studies, Hauk finds higher cooperation levels in those games which took place.[9]

Similar to the notion of voluntary participation is the idea of giving participants the possibility to choose between different settings of the game. Lazear et al. (2012) conduct dictator games with sorting options. They observed that individuals sort by preferences into different settings and argued that this kind of self-selection can create very different outcomes. The problem of sorting and self-selection in laboratory experiments has been widely acknowledged at a different level; namely, the sorting of people into the pool of participants. As participation is voluntary, not everyone who is invited takes part in the experiments. This process may give rise to systematic self-selection. Another well-acknowledged source of selectivity is the pool of invited participants. Those who are invited to participate do not usually form a random sample of the population for they consist mainly of college students. This second source is found to cause the results to be subject to a much higher degree of bias (Gaudecker et al. (2011)).

4.3 The model

This section describes how agents form their beliefs, determine their strategy and decide how often they will participate in social interactions. Furthermore, it derives some of

[8] There were two different exit incentives, where the "low" incentive was equal to the expected payoff of the game.

[9] A game only takes place when both players mutually agree to interact.

the properties that constitute the agents' propensity to cooperate and to take part in social interactions.

Consider a large society of size N in which strangers interact in prisoner's dilemma type of situation. Although agents engage repeatedly in these kind of encounters and might meet the same stranger again, they never recognize each other meaning that encounters have the character of one-shot interactions. Moreover, agents cannot discriminate between cooperative and defecting opponents prior to interaction, but do have beliefs about the distribution of both in the population. Agents need to decide about which move to take. Each agent has two actions available: to cooperate (i.e. to be helpful, truthful, honest and the like) or to defect (i.e. to cheat, to lie, to steal etc.). The action set $m_{it} = \{0, 1\}$ with $m_{it} = 1$ denoting cooperative and $m_{it} = 0$ denoting defecting behavior when interacting with a stranger, is the same for all agents $i \in N$. An agent chooses the strategy that maximizes her expected benefit based on her belief about the cooperativeness of others. Yet, there is, at least partly, the possibility to avoid encounters with strangers, being that agents can choose the number of encounters optimal to them. This feature of the model is of special interest and will be explained and discussed more thoroughly below.

Payoff and strategy

When two agents interact, the two choices of moves result in four possible outcomes, each with a defined payoff. Referring to the standard notation, R (reward) and P (punishment) are the payoffs for mutual cooperation and defection respectively. S (sucker) and T (temptation) denote the payoffs for cooperation by one player and defection by the other. Expression 4.1 shows that the social dilemma of the prisoner's dilemma is a consequence of the relative size of the payoffs. Each agent prefers mutual cooperation (R) to mutual defection ($R > S$) and to an equal probability of unilateral cooperation and defection (Expression 4.2)[10]. However, at the same time they prefer unilateral defection over mutual cooperation ($T > R$) entailing that a conflict of interests arises. The dilemma rises from the fact that any individual is better off defecting irrespective of the other agent's decision, but both prefer bilateral cooperation over bilateral defection.

$$T > R > 0 > P > S \tag{4.1}$$

$$2R > T + S \tag{4.2}$$

Due to the payoff structure, the dominant strategy is to defect in traditional prisoner's dilemma games. However, this prediction is at odds with observations taken from everyday life. To explain a positive propensity for choosing cooperation in this kind of situations, the assumption is often made that agents have other-regarding preferences. Consequently the agent's basis of decision-making is not merely the expected payoff but

[10] If the inequality is not fulfilled, altering between cooperation and defection would lead to a higher payoff than mutual cooperation.

the more comprehensive notion of expected benefit (EB_{it}).[11] Besides the expected payoff, the expected benefit in 4.3 and 4.4 encompasses two components which distinguish the expected values from the way in which they are conventionally determined. It includes terms denoting a common taste for conforming to the behavior of the majority and a coefficient denoting individual loss aversion. These traits are a way of accounting for two widely observed phenomena: (i) cooperation can be the preferred strategy under certain conditions, and (ii) given the same expectations of the behavior of other parties, individuals choose different strategies. The parameter $\alpha_i = [0, 0.5]$ reflects different levels of loss aversion of agents. With decreasing values for α_i, the potential loss following encounters receives more weight than the potential gain. A lower level of α_i therefore means higher loss aversion. Considering loss aversion only does not induce a positive propensity of a rational agent to choose cooperation as her optimal strategy but causes individuals to be heterogeneous in their strategy and number of encounters even if expectations about the opponent's behavior are the same. The agent's taste for conforming to the behavior of others is the crucial element in facilitating the possibility of cooperation as the optimal strategy. It is assumed that individuals derive non-material benefit from conforming to the behavior of others i.e. from complying to a descriptive norm. Naturally, this tendency promotes conformity in the choice of strategies. The extra, non-material payoff resulting from complying to a descriptive norm is represented by the functions $f(p_{it})$ and $g(p_{it})$. For simplicity, I assume that the functions are identical for all agents and that, consequently, all agents have the same responsiveness to a descriptive norm. While $f(p_{it})$ increases in p_{it}, $g(p_{it})$ decreases with p_{it}. In this way, the descriptive norm becomes stronger and deviating more costly the more people are expected to behave in the same way. However, the non-material benefit does not exceed the material payoffs R and T.

If the perceived probability of meeting an cooperative agent is $p_{it} = 0.5$, the descriptive norm is undefined. At this point, there is no additional benefit to behaving like others, being that there is no majority to which one can conform, i.e. $f(p_{it}) = g(p_{it}) = 0$. Therefore, the dominant strategy for $p_{it} \leq 0.5$ is defection for all agents. Only for $p_{it} > 0.5$ may the difference in payoffs when defecting (left-hand side of Expression 4.6) be offset by the higher utility when conforming to what the agent expects others are doing. In this manner, there exists a possibility that cooperation will be the optimal strategy. Whether Inequality 4.6 will hold true depends on the difference in payoffs between defection and cooperation, relative to the strength of the norm which drives the difference between $f(p_{it})$ and $g(p_{it})$.[12] A sufficiently high perceived share of cooperative agents in the population is necessary to choose cooperation as optimal strategy. This is also

[11] Important theories of other-regarding behavior are theories based on altruism, reciprocity, conditional cooperation and self-identity.

[12] To study the development of cooperation in a population, only cases will be considered where cooperation is a possible rational decision, i.e. where Expression 4.6 is fulfilled for some (high) values of p_{it}. In this way, I exclude cases with extraordinary high gains from exploiting others and losses when being exploited respectively.

reflected in Expression 4.9. It will be positive for most values of p_{it}.[13] The positive slope means that cooperation becomes more attractive as the individuals perceived probability of meeting a cooperative agent increases.

$$EB_{it}(c) = p_{it}\ R\ \alpha_i + (1 - p_{it})\ S\ (1 - \alpha_i) + f(p_{it}) \tag{4.3}$$

$$EB_{it}(d) = p_{it}\ T\ \alpha_i + (1 - p_{it})\ P\ (1 - \alpha_i) + g(p_{it}) \tag{4.4}$$

$$EB_{it}(c) > EB_{it}(d): \tag{4.5}$$

$$p_{it}\ (T - R)\ \alpha_i + (1 - p_{it})\ (P - S)\ (1 - \alpha_i) < f(p_{it}) - g(p_{it}) \tag{4.6}$$

$$\frac{\partial f}{\partial p_{it}} > 0, \quad \frac{\partial g}{\partial p_{it}} < 0, \frac{\partial EB_{it}}{\partial \alpha_i} > 0 \tag{4.7}$$

$$\frac{\partial EB_{it}(c)}{\partial p_{it}} > 0, \quad \frac{\partial EB_{it}(d)}{\partial p_{it}} > 0 \tag{4.8}$$

$$\frac{\partial (EB_{it}(c) - EB_{it}(d))}{\partial p_{it}} = \frac{\partial f}{\partial p_{it}} - \frac{\partial g}{\partial p_{it}} - \alpha\ (T - R) + (1 - \alpha_i)\ (P - S) \tag{4.9}$$

How does loss aversion influence the decision to cooperate? Expression 4.6 shows that the right hand side denoting the non-material benefit is not influenced by the level of α. However, the material payoff on the left hand side is weighted by the loss aversion parameter. It can either increase or decrease with α depending on the level of trust (p_{it}) and the relative sizes of the payoffs. Assuming that $(T - R) \approx (P - S)$ and knowing that cooperation can only be a rational choice when $p_{it} > 0.5$, a higher loss aversion lowers the trust threshold for choosing to cooperate.

Beliefs and belief updating

As the index i and it respectively indicate in expressions 4.3 to 4.6, the presumption is that individuals are heterogeneous in their degree of loss aversion and their beliefs about the behavior of others. While loss aversion is stable over time, expectations may change every period of time according to the particular experience of each encounter. It is assumed that there is no source in the economy from which an agent can get accurate information on the other agents' behavior. The only sources of information are the individual's experience from encounters of previous periods as well as some external information. However, the latter information is just random noise which varies by individuals. The individual will update her belief for each period both according to her experience of the last period and a random error term (see Equation 4.10). In this way, her expectations about the behavior of others - i.e. her level of trust - is determined endogenously and does not need to correspond to the true probability of meeting a

[13] This is very intuitive as $EB_{it}(c) < EB_{it}(d)$ holds for low values of p_{it} and $EB_{it}(c) > EB_{it}(d)$ is expected to apply for high values of p_{it}. However, depending on the norm functions $f(p_{it})$ and $g(p_{it})$, Expression 4.9 does not need to be strictly increasing over all values of p_{it}.

cooperative agent (P_t). On the contrary, as the number of encounters is rather small per period and does not adequately represent the behavior of the population, it is likely to follow the law of small numbers and result in spurious expectations.

$$p_{it} = \lambda \cdot p_{it-1} + \delta \cdot \epsilon_{it-1} + (1 - \lambda - \delta) \cdot experience_{it-1} \tag{4.10}$$

$$E(experience_{it}) \;=\; \frac{\sum_{i=1}^{N} s_{it}\; m_{it}}{\sum_{i=1}^{N}\; s_{it}} = P_t \tag{4.11}$$

The weight which is placed on the prior belief when forming a new belief is denoted by λ. The higher λ the more stable are agents' beliefs and the lower the feedback of experience made in interactions and the error term. The term $experience_{it-1} = [0, 1]$ denotes the share of cooperative opponents that the agent met in the previous period. Expression 4.11 shows that the expected value of $experience_{it-1}$ equals the true probability of meeting a cooperative agent. The latter is the number of cooperative moves ($\sum_{i=1}^{N} s_{it}\, m_i$) relative to the number of all moves played ($\sum_{i=1}^{N} s_{it}$). In addition to past experience, a random error term $\epsilon_{it-1} = [0, 1]$ is also assumed to influence the agent's belief by giving it small trembles. Including an error term in the updating process avoids an unreasonable situation in which an agent no longer updates her beliefs when having decided not to participate in encounters. It therefore avoids the eventual deadlock where all agents choose not to participate in encounters. The strength of the error term is determined by the coefficient δ. When beliefs are updated, the weight of the error term has a strong influence on the emerging level of cooperation. It is responsible for the bias of beliefs towards its expected value. For simplicity, the parameters λ and δ are assumed to be the same for all agents.

Number of encounters

Based on her preferences and her belief about the probability of meeting a cooperative opponent, an agent chooses her strategy and the optimal number of interactions with strangers. Each encounter costs the agent an amount c. An agent will only choose to participate in an encounter if the expected benefit offsets the cost. While the cost of encounters is presumed to be constant, the utility gained from encounters with strangers is assumed to decrease according to the number of interactions (see Expression 4.12).

$$\max_{s_{it}} U_{it} \;=\; (s_{it}\; EB_{it})^{\beta} - s_{it}\; c \;\text{ with }\; \beta < 1 \tag{4.12}$$

$$s^*_{it} \;=\; \frac{\left(\frac{\beta\; EB_{it}}{c}\right)^{\frac{1}{1-\beta}}}{EB_{it}} \tag{4.13}$$

$$\frac{\partial s_{it}}{\partial c} < 0,\; \frac{\partial s_{it}}{\partial EB_{it}} > 0,\; \frac{\partial s_{it}}{\partial p_{it}} > 0 \tag{4.14}$$

$$P_t \geq \frac{\sum_{i=1}^{N} m_{it}}{N} \tag{4.15}$$

where $EB_{it}(c) \geq EB_{it}(d) \rightarrow EB_{it} = EB_{it}(c); EB_{it}(c) < EB_{it}(d) \rightarrow EB_{it} = EB_{it}(d)$

As noted above, the number of encounters chosen is an important element of the model being that it is crucial for the level of cooperation in the population. This becomes clear when looking at Equation 4.6, 4.11 and the last term in Equation 4.14. These expressions indicate that cooperation is more likely to be the dominant strategy for agents with high levels of p_{it}. These trustful and cooperative agents tend to choose more encounters than agents with lower levels of trust who will rather defect. This tendency generates a selection effect and the result is that the probability of meeting a cooperative agent (P_t) is higher than the share of cooperative agents in the population. This is indicated in Expression 4.15. Thus, allowing agents to freely choose the number of encounters will have a strong, positive impact on the probability of meeting a cooperative agent. To analyze this effect more thoroughly and to relate it to differences in urban and rural levels of cooperation, the simulation is performed with different restrictions on the number of encounters (see Table 4.1 below). The emphasis is on Setting 3 which considers two different locations in which agents live: rural and urban. Those locations have different restrictions on the number of interactions between strangers.

Urban and rural areas

The principal part of the simulation will analyze the different levels of cooperation and trust between agents living in rural and urban environments. Although interactions can take place between agents coming from urban and rural areas (matching is entirely random), there are different limitations to the number of encounters in both locations. In rural areas, agents have more possibilities for circumventing interactions with strangers and so interact in networks of known people. On the other hand, even if they really enjoy interaction with strangers, they are not able to do so because occasions are limited. Urban areas allow a higher number of interactions but the possibilities to circumvent interaction with strangers are limited. Hence agents are not entirely free in choosing the number of encounters. There is an upper and a lower bound restricting the number of interactions which actually take place. The difference in bounds between rural and urban areas reflect different degrees of anonymity. In each period a certain number of agents are able to migrate between those regions. An agent will migrate if this allows her to get closer to her optimal number of encounters.

Mobility of agents

With regard to the question of why there are urban-rural differences, the mobility of agents should be considered. If agents are freely mobile and can change their sphere of activity without restriction, then agents with a high level of trust will sort themselves

into urban areas where they can enjoy a higher number of encounters. They will migrate back to rural areas as soon as they lose trust either through certain experiences coming from encounters or through small shocks by the error term acting on their beliefs. Taking the last term of expression 4.14 into consideration, the average level of trust will tend to be higher in urban than in rural areas.

This tendency will change with higher mobility constraints. There are two implications of restricted mobility. First, there is an effect on the probability of meeting a cooperative agent. Mobility constraints imply that individuals with an increased level of trust are potentially unable to move to an urban area and increase their number of encounters. The same holds true for individuals who have a decreased level of trust and who would like to migrate to rural areas so reducing the number of encounters. As we have already seen, there is a direct link both between an agent's level of trust and the optimal number of encounters, and between an agent's level of trust and the choice of strategy. Hence, restricted mobility will lead to more encounters for people with a lower level of trust and less encounters for trustful people. The explanation is that some individuals with low trust have to participate in more encounters than they consider to be optimal. At the same time, some agents with a relatively high level of trust cannot take advantage of the high number of encounters that they consider to be optimal for their interests.

Settings

The simulation will be conducted in different settings with respect to restrictions on the feasible number of encounters (see Table 4.1). The first setting will mirror the way in which the conventional prisoner's dilemma game is set up. Each agent has exactly one encounter per period. Participation is compulsory. In this setting, the share of agents who choose cooperation as their preferred strategy equals the probability of meeting a cooperative agent. In the second setting, agents are free to choose their optimal number of encounters per period with only an upper limit.x[14] In this way, participation is voluntary. The formal analysis above showed that voluntary participation does not affect the initial share of agents who choose to cooperate. However, it has an effect on the probability of meeting an agent who behaves cooperatively. Voluntary participation induces the share of agents who play a cooperative strategy to be smaller or equal to the probability of being matched with an agent who behaves cooperatively. As agents learn through the experience gained from encounters, the steady state level of trust and the share of cooperative moves is expected to be higher than in the first setting. In the third setting, rural-urban differences in the upper ($s_{\max}$) and lower bound ($s_{\min}$) for the number of encounters are introduced such that $s_{\min_{rural}} = 0 < s_{\min_{urban}}$ and $s_{\max_{rural}} < s_{\max_{urban}}$. Hence, only agents in the rural areas have the option to avoid encounters. A certain number of agents are allowed to move between rural and urban

[14]To simplify the matching process and facilitate the computational simulation, an upper limit to the number of encounters an agent can choose is necessary.

Table 4.1: Different settings of the model

Course of action
Setting 1 - one interaction per Period
• Agents choose their strategy • Agents are randomly matched • Agents interact once with another agent given their chosen strategy • Agents update their beliefs
Setting 2 - unrestricted number of interactions per period
• Agents choose their strategy • Agents determine optimal number of interactions (s_{it}) • Agents are randomly matched s_{it} times • Agents interact based on their chosen strategy • Agents update their beliefs
Setting 3 - restricted number of interactions per period
• Agents choose their strategy • Agents determine optimal number of interactions (s_{it}) • Based on s_{it}, agents decide about migration between rural and urban areas • Some Agents are allowed to change urban status • The number of actual interactions is determined based on regional restrictions ($s_{it\ actual}$) • Agents are randomly matched $s_{it\ actual}$ times • Agents interact based on their chosen strategy • Agents update their beliefs

areas in each period. [15] In regard to restrictions, the third setting lies between the very restrictive first setting and the second setting with (almost) no restrictions. I would therefore expect steady state levels of trust and cooperation to lie between the two other settings.

Course of action

[15] The restriction of migration between rural and urban areas is necessary to distinguish the third setting from the preceding second setting. If agents had no restriction in moving between rural and urban areas, they would have no restriction in choosing their optimal number of encounters as they can continuously switch to the area which allows them their optimal s_{it}.

At the very outset, each agent is uniquely endowed with a prior belief about the share of cooperative agents in the population. Beliefs are uniformly drawn from the interval $[0, 1]$ and randomly assigned. In the same way, agents are endowed with a level of loss aversion and are randomly distributed over locations. At the beginning of each period, agents choose their strategy and determine the optimal number of interactions with strangers based on their beliefs about meeting a cooperative agent and their preferences. If the agent's optimal number of encounters is not in the feasible range, the agent will be assigned the closest possible number of encounters. If migration is possible and would allow her to approach the optimal number of encounters, the agent will move to the other area and remain there. Restrictions on the possible number of encounters and migration differ according to the settings of the game (see Table 4.1). Agents are then randomly paired independent of their location status and interact with each other. The period ends when all interactions have taken place. Agents do not learn about the outcome of their interactions immediately, but only at the end of each period. In this way, an agent has no incentive to change her strategy between encounters within a single period.[16] At the beginning of the new period, agents update their belief about the behavior of others according to their experience derived from the previous period. Given their updated belief, they decide again about the number of encounters in which they would like to take part, whether they would like to migrate if possible and which strategy they would play when meeting a stranger.

Steady state

For each setting described in Table 4.1, the steady state level of cooperation, the number of encounters and the distribution of trust will be analyzed. A steady state here refers to a situation where the period-to-period changes in the share of cooperative agents are negligible and oscillate about a locally stable value. In such a situation the participation or cooperation rate will not diverge away rapidly subsequent to small shocks.

The choice of strategy depends strongly on individual beliefs about the level of cooperation of others. The dependency of beliefs on past experience suggests that the process is strongly path-dependent. If agents have negative experiences in encounters, then they will update their beliefs and may also change their behavior to defection, thereby amplifying the consequences of defecting behavior. The nature of this feedback effect suggests that steady state rates of cooperation tend towards the extreme values of zero and one. Figures 4.1 and 4.2 corroborate this intuition. They both depict in a simplified way how the probability of meeting a cooperative agent (P_t) depends on the average individual belief in the probability of meeting a cooperative agent ($\bar{p}_{it} = E(p_{it})$) for different

[16] It may seem odd to not adjust immediately to the experience made. However, it is a more reasonable assumption if periods are considered to be rather short like one day. It then is more plausible that agents do not change their strategy ad-hoc after each encounter.

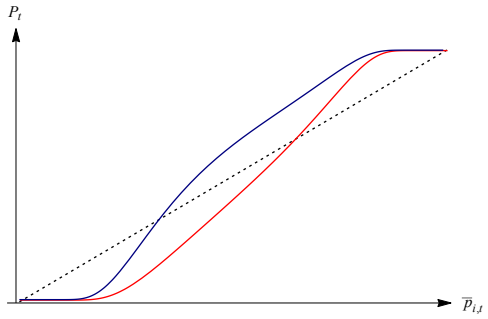

Figure 4.1: Possible steady states for Setting 1 (light graph) and 2 (dark graph), 45°-line (dashed graph)

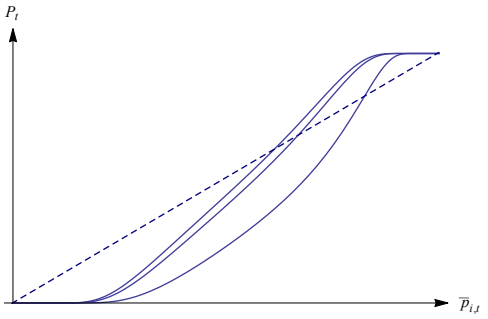

Figure 4.2: Possible steady states for Setting 1 with different norm functions (strength of norm increases from left to right)

settings and norm functions respectively.[17] The intersection with the dashed 45°-line, denotes the average level of belief, $\bar{p}_{it}$, that is necessary if the same expected probability of meeting a cooperative agent is to result. If the function is below the 45°-line, then the distribution of belief results in an expected probability of meeting a cooperative agent which is lower than the average belief. As a consequence, individual beliefs will, on average, be updated downwards. How much the average belief will decrease per period depends on the parameters λ and δ in the belief updating equation 4.10. The average belief will eventually approach zero. The opposite applies for values of the function that are above the 45°-line, meaning that the distribution of beliefs results in an expected probability of meeting a cooperative agent which is higher than the average belief. Beliefs will be updated upwards. The equilibrium at the intersection with the 45°-line is hence unstable, while equilibria at 1 and 0 are stable.

Figure 4.1 depicts the relationship of $\bar{p}_{it}$ and P_t for Setting one (light graph) and Setting two (dark graph). The difference between these two functions is caused by the possibility of choosing the optimal number of encounters. Hence, each agent's strategy is weighted with the number of chosen interactions for Setting 2. As a consequence, the expected probability of meeting a cooperative agent exceeds the average belief in

[17] For illustrative purposes, heterogeneous beliefs are assumed to equal on average last period's expected share of cooperators, P_{t-1}. This applies, for instance, when the individual's perception is determined by information on a number of randomly selected situations in which individuals decide about behaving cooperatively. In this way, beliefs will follow a binomial distribution. Assume that in each period, an individual receives information of n random situations of the described kind, where n is a positive but rather small number. Those observations will shape her perception of how many people would cooperate in the situation described above. The individuals current p_{it} is then formed by her observations of the previous period. As n becomes large, information becomes finer and more accurate. Having a fraction of random encounters as basis for beliefs formation, it is sensible to assume that beliefs about the share of cooperative individuals in the population are not necessarily correct but correspond on average to the true fraction.

the population at lower levels compared to Setting 1. The threshold level of trust for an emerging high steady state level of cooperation is lower in Setting 2 than in Setting 1. The difference between the two functions is influenced by all the parameters that affect the number of chosen encounters (e.g. the cost of interacting). The threshold of both functions is influenced by parameters that affect the strategy choice, such as the K-index. This is illustrated in Figure 4.2. It depicts the relationship of $\bar{p}_{it}$ and P_t in Setting 1 for different strength of the norm. The maximum and minimum value of the norm functions $f(p_{it})$ and $g(p_{it})$ of equations 4.3 and 4.4 decrease from left to right resulting in a lower strength of the norm. As a result, the threshold level of trust for high steady state levels of cooperation increases.

4.4 Expected effects and steady state attributes

One should note that the two problems of interest in this simulation are (i) to achieve a positive level of cooperation in the steady state, and (ii) to see what determines differences in the level of trust between rural and urban areas. For each setting, the steady state level of cooperation, the distribution of beliefs and the distribution of the number of encounters are analyzed. Furthermore, for the third setting I will evaluate rural-urban differences in the level of trust and cooperative behavior, and the sorting of agents with different degrees of loss aversion.

To examine the sensitivity of the dynamic system to parameter values, it is useful to look at how those values affect the steady state rates of participation and cooperation. For reasons of clarity and comprehensibility, not all the parameter values will be varied, only three specific ones: the incentive to cooperate (K-index of cooperation (Rapoport (1967))[18]), the cost of interactions, and the potential migration rate. These parameters influence the initial share of agents who choose to cooperate and the average number of encounters chosen. Both are important attributes for the emerging level of cooperation being that they influence the initial share of cooperative moves played. While the K-index has a very immediate influence on the emerging level of cooperative behavior, the latter acts in an indirect way. If incentives to interact with strangers are high because the cost of interaction is low relative to the expected benefit, then a high number of agents will choose to interact. Agents will subsequently also interact if their expectation to meet a cooperative agent is relatively low. Agents with little trust are more likely to choose to defect being that the norm effect of conforming to cooperative behavior is weaker at low levels of trust and will, in turn, weaken the selection effect. The consequence is that the likelihood of meeting a cooperative agent decreases with an increasing initial number of encounters. As noted above, the share of cooperative moves played is further influenced

[18]The K-index denotes the relative size of the payoffs and for the two-person dilemma is given by $K = (R - P)/(T - S)$

by restrictions on the number of encounters. If agents cannot play their chosen number of encounters and instead have to play more or less often than optimal then, when weighted by the number of interactions, the average level of trust of interacting agents tends to be lower.

Given the formal analysis in Section 4.3, it is impossible to draw clear conclusions in regard to differences in the distribution of cooperativeness and trust in urban and rural areas. One might instead speculate that the rate of potential migration has a strong effect on the differences between both locations. If mobility is without restriction, which is the case in Setting 2, then agents with a high desire for encounters with strangers will sort into urban areas while other agents will move to rural zones. Being that agents with a high desire for encounters with strangers tend to be more trustful, the level of trust of agents will be higher in urban areas. As soon as they loose trust, agents will to sort into rural areas and vice versa. Again, one can speculate that the empirically observed difference in trust between rural and urban areas evolves only when there is a quite high restriction on migration possibilities. There is hence a mismatch of the desired and realized number of encounters for a considerable part of the population. How does this affect cooperativeness and the level of trust in urban and rural areas? In regard to their level of cooperativeness, agents with a low level of trust have the possibility of avoiding encounters in rural but not in urban areas. In addition, for agents in urban areas the number of encounters is higher, which is likely to result in a lower share of cooperative moves played by urban agents in comparison to rural agents.

For urban agents to have also a lower level of trust than rural agents, the probability to meet a cooperative agent needs to be rather low. In this way, the updating of expectations in urban areas tends to lead to a decrease in trust. This decrease may be lower in rural areas where agents can avoid interactions.

In the next Section, the setup of the simulation will be described. The simulation results for the settings described above is presented in the subsequent section.

4.5 Simulation

The program for modeling agents' behavior and simulating encounters is written in *Python* in object-oriented code. The pseudocode and used parameter values can be found in the Appendix. All results are averaged over 10 simulations and each simulation includes 2000 agents across 500 periods. At the beginning, each agent is endowed with an initial value for her beliefs, her loss aversion and a location status. Each value is a random draw from a uniform distribution of possible values. The average initial level of trust therefore is $E(p_{i,0}) = 0.5$, the average degree of loss-aversion is $E(\alpha_i) = 0.25$

and the expected share of agents living in a rural area is 0.5. None of the variables are initially correlated. Hence, regardless of their degree of loss aversion or level of trust, each individual is initially designated to a rural or urban area with equal probability.[19]

In the model described above, the norm functions are not explicitly defined, except for their relative size which changes with p_{it}. Without loss of generality, the norm functions take on a simple non-linear form (see equations 4.16 and 4.17 and Figure 4.3). Similar qualitative results are produced by either more elaborate or simpler functions which fulfill the conditions noted in Section 4.3. Figure 4.4 depict how the difference in expected benefit between cooperation and defection changes by the level of trust and varying incentives to cooperate.

$$EB_{it}(c) = p_{it}\ R\ \alpha_i + (1-p_{it})\ S\ (1-\alpha_i) + (2\ p_{it})^x - 1 \quad (4.16)$$

$$EB_{it}(d) = p_{it}\ T\ \alpha_i + (1-p_{it})\ P\ (1-\alpha_i) + 1 - (2\ p_{it})^x \quad (4.17)$$

$$EB_{it}(c) > EB_{it}(d): \quad (4.18)$$

$$\frac{R-T+x\ (4\ p_{it}-2)}{P-S} > \frac{(1-p_{it})\ (1-\alpha_i)}{p_{it}\ \alpha} \quad \text{possible for } p_{it} > 0.5 \quad (4.19)$$

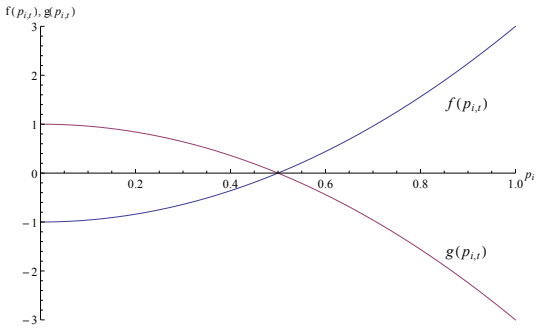

Figure 4.3: Behavior of norm function $f(p_{it}) = (2\ p_{it})^x - 1$ and $g(p_{it}) = 1 - (2\ p_{it})^x$ with increasing p_{it} for $x = 2$

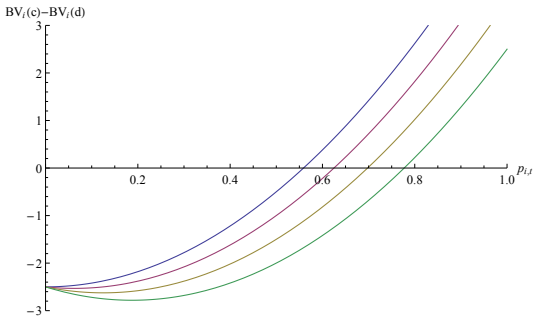

Figure 4.4: Corresponding difference between expected benefit of cooperation and defection with increasing p_{it} for different K-values (decreasing from left to right)

The parameters are chosen in a manner that allows for the initial share of agents who choose to cooperate [20] as well as the average number of encounters chosen to be strictly

[19] The location status has no consequence for Setting 1 and 2 but only for Setting 3.

[20] As noted earlier, the share of agents who choose cooperation as preferred strategy is not necessarily equal to cooperative moves in one period. As the latter is equal to the share of agents who choose

positive. Given the initial random distribution of beliefs and degrees of loss aversion, the share of agents who choose cooperation is expected to be lower than one half.[21] To account for the parameter sensitivity of results, simulations are run for different values of the initial share of agents who choose cooperation alongside the average number of encounters played. Those variables are in accordance with changes in the K-index, the cost of interaction and the potential migration rate.

Each simulation will be conducted for combinations of differing initial conditions:

1. the initial share of agents who choose cooperation varies between 0.23 and 0.48

2. the initial level of participation of agents in interactions varies between 1.9 and 4.5

4.6 Results

The analysis of the results will be conducted in three parts. The first part focuses on the role of voluntary participation for the steady state level of cooperation. When comparing the three different settings, it can be clearly see that voluntary participation affects the emerging steady state level of cooperation positively. As noted above, a steady state refers here to a situation where period-to-period changes in the aggregate level of cooperation are negligible. Due to random matching, the steady state level of cooperation oscillates closely around a locally stable level of cooperation. The second part of the analysis shows the development of an agent's level of trust and her subsequent choice of strategy and number of encounters. The third part focuses on differences in behavior and trust of agents in rural and urban environments.

4.6.1 Voluntary participation and level of cooperation

As outlined above, voluntary participation generates a selection effect which increases the number of cooperative moves played relative to defective moves. Different restrictions in voluntary participation influence this selection effect and so the emerging level of cooperation. Analysis of this effect is performed by comparing the evolution and the steady state levels of cooperation in the different settings.To gain a better understanding of the role of voluntary cooperation, I compare results from two versions of the game for

cooperation weighted by the number of played games, they most likely differ in games with voluntary participation.

[21] Due to the assignment of initial values of p_{it}, the expected level of trust is $E(p_{it}) = 0.5$. Given the payoff structure of a prisoner's dilemma, only individuals with a level of trust that is sufficiently higher than 0.5 are likely to choose to cooperate.

all settings: a game with a relatively high incentive to cooperate (high K-value) and a game with a lower incentive to cooperate (lower K-value). Changes in the incentive will cause variation in the initial share of cooperative moves played. This share is essentially driving the experience derived from encounters and therefore has a strong influence on the subsequent change in beliefs and the strategy chosen. Hence, the initial share of cooperative moves played is key to the development of trust in the population. The incentive to cooperate is altered by the K-index, i.e. the relative size of the payoffs. However, the general payoff structure of a prisoner's dilemma is maintained.

Figures 4.5 - 4.7 depict characteristic patterns of the development of key variables. They show the progress of the average level of trust (i.e. the average level of p_{it} in the population), the share of cooperative agents in the population and the average experience derived (i.e. the share of last period's cooperative moves played). Table 4.2 presents the respective initial and steady state values for all three settings. While the share of cooperative agents equals the share of cooperative moves played in the first setting (where every agent experiences exactly one encounter), they differ in settings 2 and 3. This is because agents can, to some extend, choose their optimal number of encounters in these settings.

In a second step, I vary the cost of interactions. This is a further possibility to influence the initial share of cooperative moves played. However, this variation only applies to the second and the third setting. The cost of interaction has no direct influence on the strategy that agents choose and therefore has no consequence for the development of the cooperation level in the society of the first setting. On the other hand, the impact is considerable for Setting 2 and Setting 3. Besides beliefs, the cost of interactions is the main driver of the optimal number of interactions chosen. As argued above, this relationship has an influence on the share of cooperative moves played. The results are very akin to varying the K-index. Individual figures are therefore not displayed.

The initial distribution of beliefs, level of loss aversion, location status and all fixed parameters are equal in all three settings and also in both respective versions of the game. As noted above, individual beliefs are affected by a uniformly distributed random shock with mean 0.5 in every period. This causes beliefs to be on average biased towards 0.5. The error term in the belief updating function represents random information coming from outside which varies between individuals and contributes to the formation of beliefs. The consequence is that beliefs are updated even when no interaction is experienced. Deadlocks are therefore reduced in states of mutual defection and overall non-participation in the game is avoided.

Setting 1

Figure 4.5 shows that the share of cooperative agents, and thus the share of agents who made positive experience in encounters, decreases quickly to zero. This trend holds

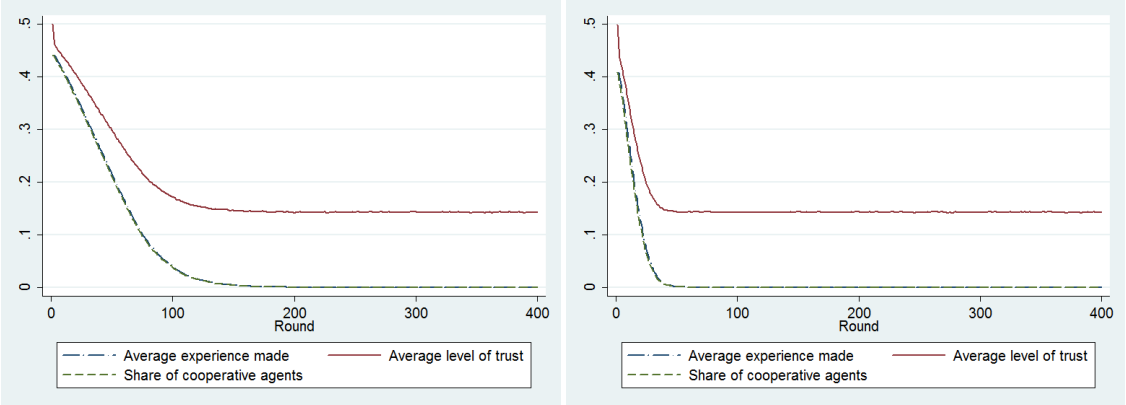

Figure 4.5: Characteristic pattern of the evolutionary process of Setting 1 with high incentive (left panel) and low incentive to cooperate (right panel)

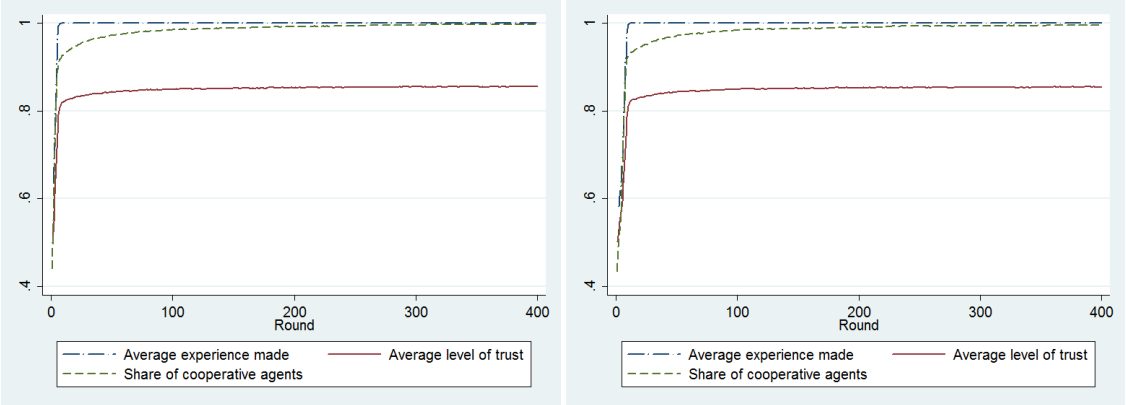

Figure 4.6: Characteristic pattern of the evolutionary process of Setting 2 with high incentive (left panel) and low incentive to cooperate (right panel)

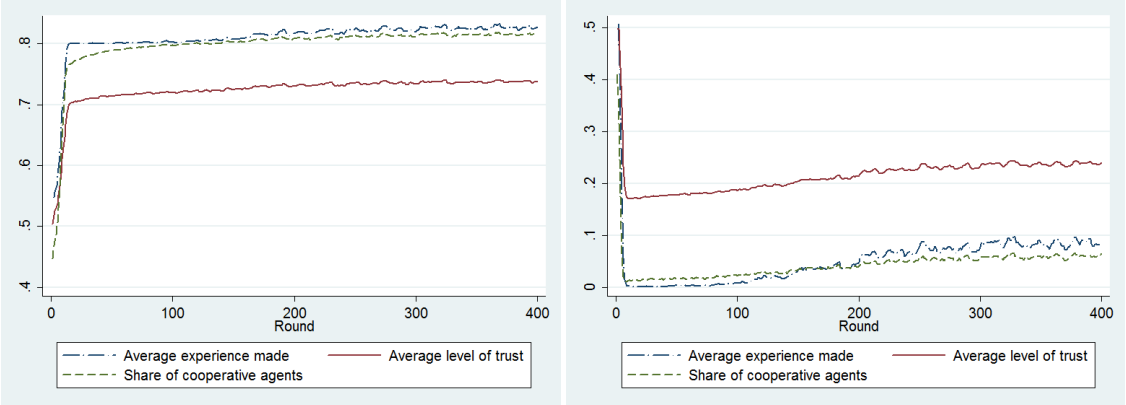

Figure 4.7: Characteristic pattern of the evolutionary process of Setting 3 with high incentive (left panel) and low incentive to cooperate (right panel)

true for both versions of the game: both the game with high incentives and the game with low incentives to cooperate. The initial expected belief is $E(p_{i,0}) = 0.5$ in both versions. At a value of $p_{it} = 0.5$ the optimal strategy is to defect even for K-values close to 1. As every agent has to play, there are on average more agents who defect than cooperate. However, there will be a certain share of agents with $p_{it} < 0.5$ who will choose to cooperate and hence a certain share of agents will have a positive experience. Agents may change from a defective to a cooperative strategy as a result of positive experience derived from encounters. However, the error term biases the beliefs towards 0.5 leading to a continuous decrease in agents' propensity to shift to cooperative behavior. The level of cooperation inevitably approaches zero, a fact which holds true for all possible initial shares of cooperative moves played. The initial number of cooperative agents merely influences the pace at which the probability of meeting a cooperative agent approaches zero. The panels in Figure 4.5 demonstrate that, in the case of high incentives to cooperate, the initial share of cooperative agents is higher than in the game with a relatively low incentive to cooperate. Consequently, more periods need to past before cooperative behavior disappears in the population. However, the average level of trust in the population remains at a comparatively high level despite the lack of positive experience gained from encounters, again due to the influence of the error term in the belief-updating process.

When the cost of interactions is varied while everything else is held constant, neither the steady state level of cooperation nor the pace at which it is approached are altered. In this setting, changes in the cost of encounters do not influence the initial share of cooperative moves played because the cost only affects the number of encounters chosen by agents but not the respective strategy played.

Setting 2

In this setting, agents can choose the number of encounters without restrictions. They can even avoid participating at all in interactions. The incentive to cooperate, and hence the initial share of agents who would choose to cooperate when interacting with others, is the same as in the first setting (see Table 4.2). However, the share of cooperative moves played and thus the share of agents who made positive experience in encounters is considerably higher than previously. The reason is that agents with a high degree of trust in the willingness to cooperate of others tend to choose to participate more often in encounters while at the same time they are more likely to cooperate themselves. Consequently, the initial level of cooperative agents is sufficient to increase the average level of trust and share of cooperative agents over the next period. Moreover, it magnifies the positive experience that agents will gain. This amplification is mitigated by the random shocks occurring during the belief-updating process which bias beliefs, on average, towards 0.5. While the level of cooperation quickly tends towards one, the average level of trust remains at a lower level. Increasing the K-value and so the incentive to cooperate

Table 4.2: Agents' level of cooperation

		Setting 1		Setting 2		Setting 3	
		mean	(sd)	mean	(sd)	mean	(sd)
Relatively high incentive to cooperate							
Initial	share of cooperative agents	0.442	(0.004)	0.441	(0.015)	0.447	(0.010)
	share of cooperative moves	0.442	(0.004)	0.634	(0.016)	0.548	(0.014)
	average number of interactions	1	(0)	2.832	(0.053)	3.092	(0.048)
Final	share of cooperative agents	0	(0)	0.998	(0.001)	0.817	(0.407)
	share of cooperative moves	0	(0)	0.999	(0.000)	0.825	(0.390)
	average number of interactions	1	(0)	4.799	(0.039)	4.116	(1.477)
Relatively low incentive to cooperate							
Initial	share of cooperative agents	0.408	(0.009)	0.411	(0.010)	0.409	(0.014)
	share of cooperative moves	0.408	(0.009)	0.581	(0.017)	0.507	(0.014)
	average number of interactions	1	(0)	3.416	(0.048)	3.063	(0.033)
Final	share of cooperative agents	0	(0)	0.996	(0.002)	0.065	(0.005)
	share of cooperative moves	0	(0)	0.999	(0.000)	0.099	(0.006)
	average number of interactions	1	(0)	5.109	(0.049)	1.327	(0.040)

Notes: *Data source:* agent-level information generated by simulation.

will increase the pace at which a high level of cooperation is achieved. The difference in the emerging steady state level of cooperation is not statistically significant.

Holding the K-value fixed and altering the cost of interactions also changes the initial share of cooperative moves played in the game. However, the agents' chosen strategy is unaffected by the cost of interactions. The higher the cost of interactions, the higher the expected benefit needs to be in order for participation in encounters. An increase in the cost of interactions will hence increase the selection effect as interactions appear less profitable to agents with a low level of trust.

The selection effect is slightly mitigated by the diminishing marginal utility from returns of encounters. Agents who have a higher degree of trust in the cooperativeness of others will expect higher returns of interactions and will thus choose to participate more often in interactions. Hence, a change in the cost of interactions will lead to higher marginal changes in the number of interactions when agents exhibit a high level of trust. When there is an upper limit to the number of encounters, this effect is very small. In the end, increasing the cost of interactions increases the share of cooperative moves played and therefore has an effect similar to the development of cooperation by increasing the K-value. Yet, the rise in the share of cooperative moves played comes at the cost of reducing the overall number of encounters taking place.

Here, the share of cooperative moves quickly approaches a high level in both versions of the game. It is also possible to achieve an opposed development of the level of cooperation towards zero. However, such a move requires the initial share of cooperative moves played to be very low and is more likely to appear when incentives to cooperate or the cost of interactions are very low.

Setting 3

In Setting 3, there are boundaries to the feasible number of encounters which differ by location status. In urban areas, both the maximum and the minimum number of possible encounters is higher than in rural areas. Only in rural areas do agents have the option to abstain from encounters. Migration between both locations is restricted. The development of the level of cooperation is similar to that of Setting 2. Yet, as speculated above, a higher initial share of cooperative moves played is needed to achieve a high level of cooperation. The reason is that individuals are not unrestricted in choosing their number of encounters. In this way, less trustful agents tend to have more encounters while more trustful agents have fewer encounters than they would have otherwise. These tendencies render the initial share of cooperative moves lower than in the second setting under otherwise equal conditions. The version of the game with a relatively low incentive to cooperate thus leads to a low level of cooperation, while the game with a comparatively high incentive results in a high level. The threshold for a low steady state level of cooperation is hence higher than in the second setting.

Determinants of the steady-state level of cooperation

As we have just seen, there is a strong path dependence in the development of the level of cooperation. The initial share of cooperative moves played shapes the experience that agents derive from encounters and therefore governs the path of development of the level of cooperation in the simulations. It determines whether interactions between agents will result in a high or a low steady state level of cooperation. The comparison of the different settings illustrates that voluntary participation has a strong positive influence on the initial share of cooperative moves played through the selection effect arising. Besides voluntary participation, the share of cooperative moves is influenced by the payoff structure (K-index) and the average number of encounters. If the share of cooperative moves played falls below a threshold, the equilibrium level of cooperation will approach zero. This threshold varies with restrictions on voluntary cooperation. The higher the restrictions, the higher is the threshold.

How do other parameters influence the steady state level of cooperation? As mentioned above, the cost of interactions can change the initial share of cooperative moves in settings with voluntary participation. Yet, the cost of interactions also has an influence on how far the level of cooperation approaches the extreme values of zero or one. Given their level of trust, the lower the cost of interactions the fewer agents will refrain from interactions. When agents do not participate in encounters, their beliefs cannot be influenced by the experience derived from encounters while they are only affected by the error term (with a mean of 0.5). A high participation rate hence leads to the error term exerting a lower influence while the experience had from encounters exerts a higher influence. Consequently, the steady state level of cooperation will converge more towards the extreme values.

The influence of the error term is also determined by δ - the coefficient of the error term in the belief updating function (Equation 4.10). A decrease in δ mitigates the effect of the error term leading again to higher convergence of the steady-state level of cooperation to the minimum and maximum value respectively.

4.6.2 Trust, strategy and loss aversion

Figures 4.8 - 4.9 show, for the three settings of the game, the development of a representative agent's belief, her participation in interactions and her experience from encounters. The dashed line depicts the threshold in trust which determines which strategy is played. The agent's optimal choice is to cooperate for trust levels above the line and to defect otherwise. The experience derived from encounters in period t is defined as the share of cooperative agents that the agent faced in this period. When the agent abstains from participation, the experience derived is, for illustrative purposes, denoted as negative.

The graphs show how beliefs are influenced by experience and how the error term affects the level of trust.

The influence of voluntary participation on the development of trust can be seen clearest in the third setting which combines voluntary and compulsory participation. An additional line between 0.1 and 0.3 is included in the graphs for this setting. This line depicts the agent's individual threshold of trust for participation. As voluntary participation in encounters requires a certain level of trust in the cooperativeness of others, the agent's optimal choice is to refrain from interactions for all degrees of trust below the line. The dependency of participation on the level of trust can be seen in the first rounds of the game in the left hand panel of Figure 4.9. The agent, who lives in a rural area, can freely choose to participate or not. Looking at the right hand panel, an agent living in the urban area is more restricted in her choice and needs to take part in encounters even if this is not an optimal choice for her. Beginning from period 120 on, she is living in a rural area and can refrain from interactions, which will have immediate consequences for her level of trust. In periods when no experience is acquired, the bias of the error term increases and beliefs are biased towards 0.5 and will subsequently increase. In such a case, trust tends to increase through non-participation and decrease through participation. This demonstrates that in a society with a relatively low level of cooperation, the level of trust can be higher with voluntary participation. Moreover, it would appear obvious that the opposite effect applies for societies with a relatively high level of cooperation. Yet, this is not necessarily true. Being that the participation decision is dependent on the level of trust, in societies with a high level of trust almost everyone chooses to participate in interactions with strangers. We see here that there often results no significant difference in the average level of trust between partial and complete voluntary participation. Only when the threshold for participation is exceptionally high for instance, caused by high costs of interaction - will a significant difference occur.

As just observed, the individual level of trust is influenced by participation in encounters through a lower weight of the error term relative to the experience derived from the encounter. Are the beliefs of participating agents then more accurate? When examining the influences on the absolute deviation of an agent's belief (p_{it}) from the true probability of meeting a cooperative agent (P_t), a higher number of encounters is seen to reduce the bias (see column (1) Table 4.3). If the true probability of meeting an cooperative agent is $0 < P_t < 1$, then the probability of making extreme experiences is lower making the bias in beliefs smaller.[22] The bias is also significantly smaller when comparing agents who have experienced one encounter and agents who have chosen not to participate.

[22]This is due to the law of small numbers. The average share of cooperative agents met is likely to be closer to the expected value if more encounters are experienced. If only one encounter is experienced the probability of the experience made to be $Pr[e_{it} = 1] = P_{it}$ and $Pr[e_{it} = 0] = 1 - P_t$ respectively. Is $s > 1$ those probability decrease quickly to $Pr[e_{it} = 1] = (P_t)^s$ and $Pr[e_{it} = 0] = (1 - P_t)^s$.

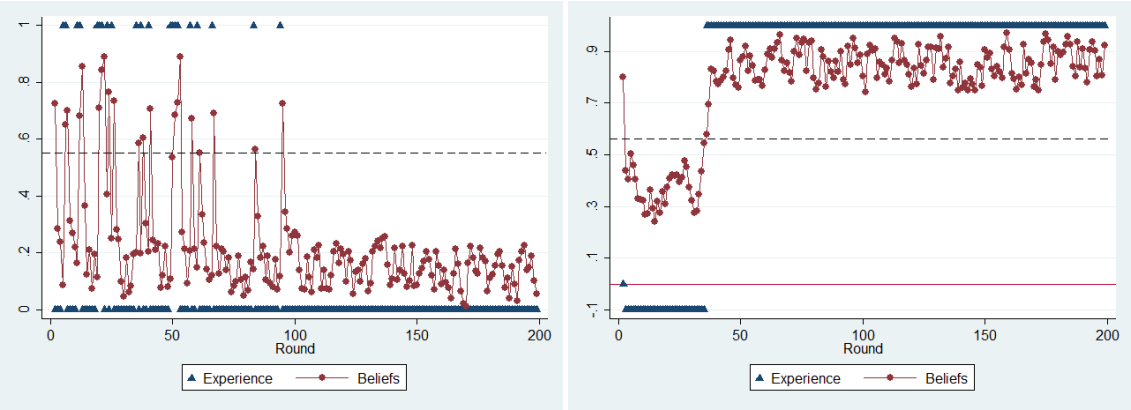

Figure 4.8: Characteristic pattern of the evolutionary process of Setting 1 with high incentive (left panel) and Setting 2 with low incentive to cooperate (right panel)

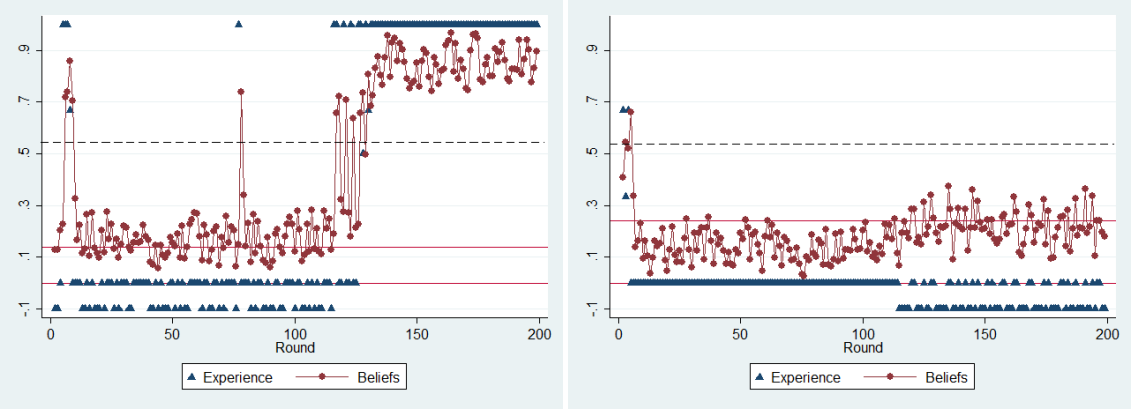

Figure 4.9: Characteristic pattern of the evolutionary process of Setting 3 with high incentive (left panel) and low incentive to cooperate (right panel)

Table 4.3: Econometric analysis of agents' trust, bias in beliefs and strategy depending on α

	All agents	Non-participating agents		Participating agents in t		
	Bias in beliefs	Trust_t	Strategy_t	Trust_t	Strategy_t	Encounters_t
	(1)	(2)	(3)	(4)	(5)	(6)
Experience_{t-1}		0.705^{***}		0.676^{***}		
		(0.005)		(0.001)		
Trust_t			1.177^{***}		1.441^{***}	5.438^{***}
			(0.041)		(0.003)	(0.016)
Alpha	0.904^{***}	-0.430^{***}	1.389^{***}	-0.030^{***}	-0.049^{***}	7.579^{***}
	(0.006)	(0.017)	(0.103)	(0.004)	(0.008)	(0.039)
Encounters	-0.099^{***}					
	(0.000)					
Constant	0.384^{***}	0.148^{***}	-0.377^{***}	0.172^{***}	-0.242^{***}	-1.784^{***}
	(0.002)	(0.003)	(0.020)	(0.002)	(0.003)	(0.016)
Observations	20000	2716	2716	17284	17284	17284
R2	0.740	0.948	0.285	0.946	0.925	0.884

Standard errors in parentheses, OLS regressions, * indicates $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Data source: agent-level information generated by simulation.

As seen in equations 4.7 and 4.14 in Section 4.3, the number of encounters chosen is influenced by the degree of loss aversion α in the way that $\frac{\partial s}{\partial \alpha} > 0$. The agents with low loss aversion (high level of α) should consequently have more accurate beliefs. The econometric analysis in table 4.3 shows that, when controlling the number of encounters, their bias of beliefs is higher and the level of trust is lower. Why are beliefs of less loss averse agents biased downwards? The degree of loss aversion determines the number of encounters chosen through affecting the expected benefit of encounters. Given a certain level of trust, the lower the degree of loss aversion, the higher the expected benefit from participation. Hence the lower the threshold of trust that is necessary for an agent to consider participation. The upshot is that less loss-averse agents start (or restart) to take part in encounters even when the perceived likelihood of meeting a cooperative agent is quite low. These agents are therefore more likely to derive a negative experience from encounters than more (cautious) loss-averse agents. Being that beliefs are, to some extent, based on previous periods' experience, their beliefs tend to be lower. Hence, there is a correlation of beliefs and preferences which is caused by different thresholds for participation and the associated experience which agents gain in encounters.

The relationship between loss aversion and the strategy chosen, covered in Section 4.3, is also reflected in the results of Table 4.3. The econometric analysis uses agent-level

data generated by the simulation. While less loss averse non-participating individuals (with a relatively low level of trust) are more likely to chose to cooperate (column (3), participating loss averse agents (with a higher level of trust) are more likely to chose to defect (column (5)).

4.6.3 Rural-urban differences

Individuals who are loss averse have a lower participation rate or even avoid interactions more often than identical agents with lower loss aversion. It is therefore not surprising that the simulation results show a sorting of loss averse individuals into rural areas, where agents can avoid encounters with strangers. Figure 4.11 and Figure 4.15 depict the sorting into specific locations of agents with different degrees of loss aversion. While the initial distribution of α is the same in both areas, the panels show how, after 1000 periods played, agents have sorted into areas. In addition, the panels show that, with a high steady state level of cooperation, a greater number of agents want to live in urban areas. However, being that the level of cooperation is relatively low, only a few would choose to live there. The reason is that the level of cooperation in a society is correlated with the average individual belief and ergo the optimal number of encounters with strangers. The higher the perceived level of cooperation, the more individuals are willing to interact with a greater number of agents.

The potential migration rate[23] is very important for the difference in levels of trust and cooperation between rural and urban areas. Without restrictions on mobility between rural and urban areas (Setting 2), the level of trust will always be higher in urban areas than in rural environments. As soon as agents gain sufficient trust through positive experience of encounters or through the error term, they will increase their number of encounters. Agents will then sort into urban areas and this immediate sorting therefore leads to higher levels of trust in urban areas. The heterogeneity in loss aversion mitigates this difference slightly.[24]

In this regard the feature of limited mobility in Setting 3 proves more interesting. Being that only a certain number of agents per period have the opportunity to move between areas, local restrictions entail that agents occasionally need to deviate from their optimal number of encounters. The figures 4.12, 4.13 and 4.16, 4.17 show the steady

[23] As noted in Section 4.3, each period a fixed number of agents is randomly chosen and given the opportunity to change their environment. An agent will decide to move to another location if it allows him to approach her optimal number of chosen encounters. If all the chosen agents decide to move then the potential migration rate is equal to the actual migration rate. In general, the potential rate exceeds the actual rate.

[24] In Setting 2 as well as Setting 3 there is a sorting of less loss averse agents into rural areas despite a relatively low level of trust. Yet, the heterogeneity in preferences does not offset the higher level of trust through mobility in the given setting.

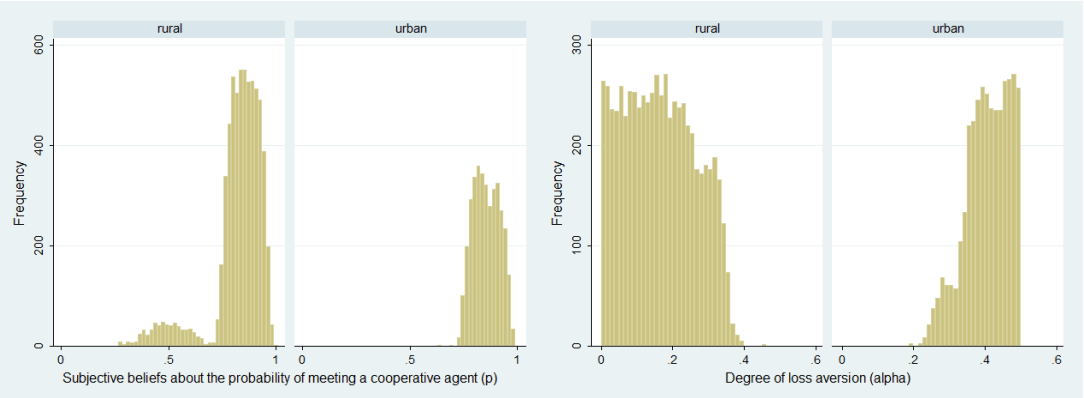

Figure 4.10: Distribution of trust in rural area (left-hand panel) and urban area (right-hand panel) under high incentive to cooperate

Figure 4.11: Distribution of loss-aversion in rural area (left-hand panel) and urban area (right-hand panel) under high incentive to cooperate

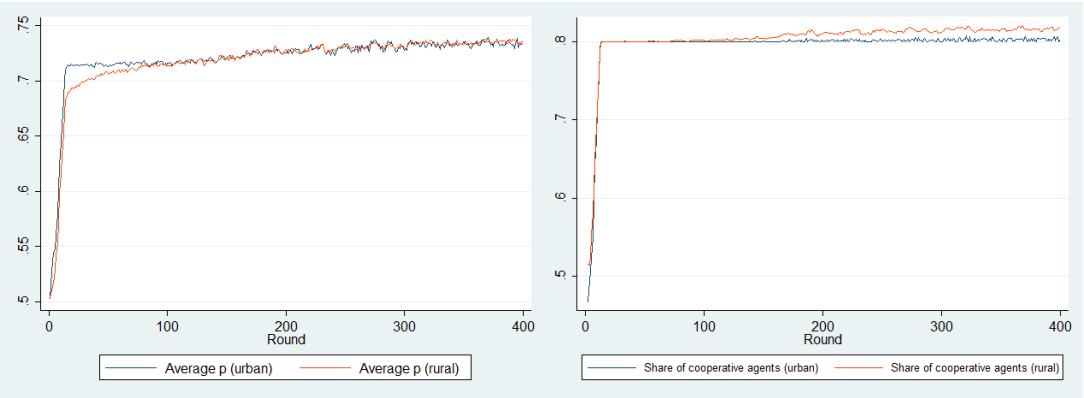

Figure 4.12: Development of the average level of trust in the urban and rural population under high incentive to cooperate

Figure 4.13: Development of the share of active cooperative agents in the urban and rural population under high incentive to cooperate

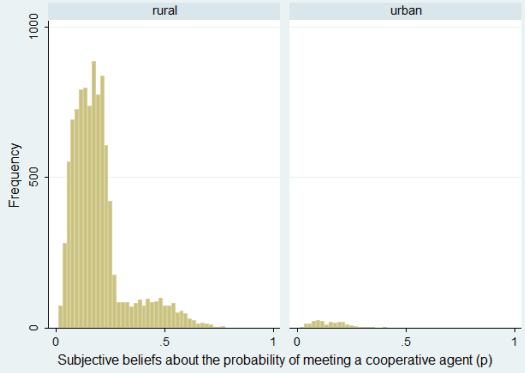

Figure 4.14: Distribution of trust in rural area (left-hand panel) and urban area (right-hand panel) under low incentive to cooperate

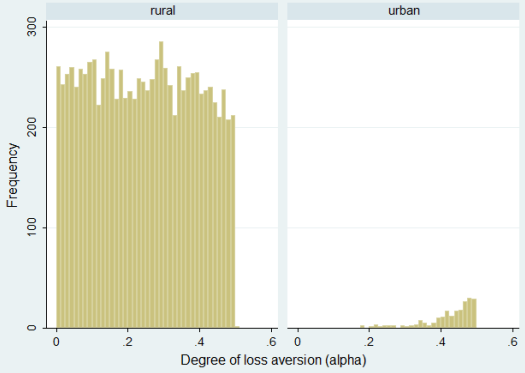

Figure 4.15: Distribution of loss-aversion in rural area (left-hand panel) and urban area (right-hand panel) under low incentive to cooperate

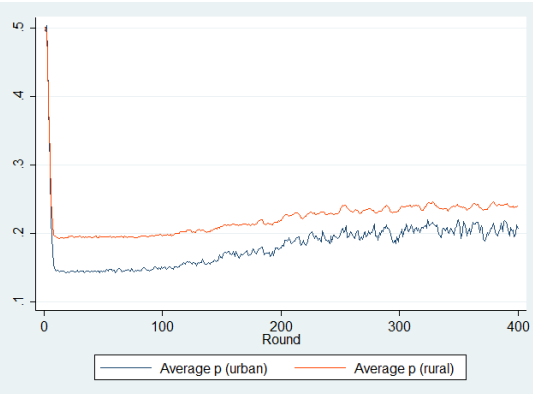

Figure 4.16: Development of the average level of trust in the rural and urban population under low incentive to cooperate

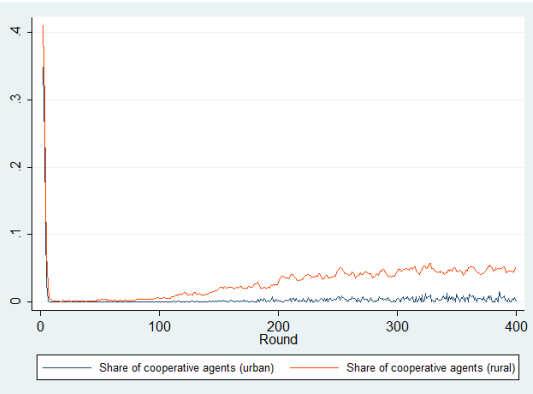

Figure 4.17: Development of the share of active cooperative agents in the urban and rural population under low incentive to cooperate

state level of trust and cooperation in rural and urban areas for the two versions of the game. It can be seen here that there is a high incentive to cooperate resulting in a high level of cooperation and a relatively low incentive to cooperate resulting in a low level of cooperation. In both versions, differences between urban and rural environments emerge in regard to cooperation, but this feature is more pronounced in the latter version.Where there is a low level of cooperation, many agents have negative experience and prefer to reduce the number of encounters or even to avoid them at all. However, in urban areas this choice is not always possible. As a consequence, the level of trust decreases for those agents and is lower than in urban areas in the setting where there are restrictions of migration. This trend is also reflected in a lower rate of cooperative agents who engage in social interactions. For the applied potential migration rate, the level of trust and cooperation in urban areas falls significantly below the levels in rural areas (Figure 4.16 and Figure 4.17). In general, the more restricted the mobility between rural and urban areas, the higher will be the difference in trust and cooperativeness of agents. The development of urban and rural level of trust is a slightly different for a high level of cooperation. While there is no significant difference in the level of trust, the share of cooperative agents taking part in interactions is higher in rural than in urban areas. The reason is that agents with a relatively low level of trust can avoid interactions in rural areas but not in urban areas. These less trustful agents also tend to behave defectively more often.

4.7 Discussion and conclusion

The analysis has taken up two paradoxes. The first puzzle is that we observe considerable levels of cooperation in situations where interactions are one-shot and completely anonymous. These occur in everyday life as well as in laboratory and field experiments. The problem of cooperation in transitory and anonymous interactions is hence one of the theoretically most compelling in social dilemmas. The second puzzle is that individuals in rural areas tend to behave more often cooperatively than in urban environments. The observed differences in helping and cooperative behavior may be due to various injunctive norms of helping, and because of differences in the availability of institutional support services. However, the fact that differences are insignificant in this kind of behavior between related individuals (friends and relatives) suggests that the influence of an injunctive norm might be rather small.

The paper has outlined a micro-structure with the necessary conditions using agent-based modeling which lead to the observed urban-rural differences in macro behavior. In this analysis, peoples' beliefs about the level of cooperation in the population and their subsequent choices are determined endogenously; they are mainly driven by the experience that they derive from interactions. Although the results are presented within the context of a prisoner's dilemma, I belief that the results can be generalized and

applied to many social dilemmas in anonymous situations. The simulation shows how trust and cooperation can emerge without formal or informal control, and how these differences between rural and urban environments evolve. I introduce features which are often found in real world interactions: imperfect information, voluntary participation and a taste or tendency to conform to majority behavior. The latter therefore allows for the possibility of cooperation to be the individually optimal strategy. The key result to be considered is that voluntary participation can facilitate a stable level of cooperation in a population. The option to refrain from participation generates a selection effect that may induce cooperative behavior that persists in the long-run. The factors that give rise to rural-urban differences are firstly, heterogeneity in loss aversion and secondly, limited migration opportunities between rural and urban areas. These factors apply independent of whether a high or a low steady state level of cooperation emerges in the population. Nonetheless, differences are more pronounced for low levels.

Another interesting result is that preferences for gains and losses (here denoted by the loss aversion parameter α) are correlated with beliefs. Agents with different preferences behave differently in otherwise equal situations and consequently take different experiences from encounters. Experience is then the channel which links preferences and beliefs. To my mind, this is an observation that applies beyond this specific model.

Besides experience, external information is decisive for the level of cooperation that emerges in a society. The simulation shows what has been observed in many experiments: an individual's cooperative behavior is conditional on other peoples' cooperativeness. If an individual is exposed to relevant social information, it may lead her to revise her beliefs and her choice of strategy may change. In the derived model here, the influence of information on decision is mediated by a descriptive social norm. Telling an individual about the behavior of others influences her beliefs about the descriptive norm i.e. the perception of what the other individuals are doing. This information may in turn influence her behavior in order to avoid the discomfort of being different from others. This kind of conditional cooperation can be interpreted as complying to a descriptive norm or conforming to majority behavior. Yet, it can also be interpreted as generalized reciprocity.

The very nature of conforming behavior and belief updating based on experience implies that all participating agents eventually strive towards one particular common strategy. For the strategy chosen, only the influence of external random information on beliefs avoids complete homogeneity. In other words, different preferences still generate heterogeneity in the number of encounters chosen.

Further remarks may be in order. One possible objection to the model's setup is that the decision about the strategy is completely independent of the opponent. Type-dependent beliefs as in Gamba (2013), are thus ruled out in this setup. and the application of this model is then reduced to very short and transitory encounters or interactions

which are not face-to-face (like internet activities) and which do not allow for the discrimination of different types of persons. It is clear that introducing the possibility of discrimination would generate a way more complex model that cannot be handled in the scope of this paper. Another concern may be the assumption of random matching. When behavior is locally homogenous but varies between locations, the random matching assumption requires highly mobile agents. Hence, the assumption limits the scope of the results to situations in which people are very mobile in their interactions.

Outlining a possible micro structure which leads to frequently observed behavior does not provide a direct answer to the paradoxes pointed out above. Nevertheless, it contributes an intermediate result that may prove useful in answering the questions that have been posed. In addition, it brings to mind the important role of voluntary participation as a feature not only for modeling but for conducting lab experiments. There is experimental evidence that participants are willing to exit dictator games even if this option is costly (see e.g. Dana et al. (2006) and Broberg et al. (2007)). Allowing for a selection effect through voluntary participation may lead to highly contrasting results.

4.8 Appendix

4.8.1 Overview of variables and parameters

Table 4.4: Variables, Parameters and their values used in the simulation

Variable/Parameter	Description	Value (range)
p_{it}	Agent's expected probability of meeting a cooperative agent	(0, 1)
α_i	Agent's degree of loss aversion	(0, 0.5)
$urban_{it}$	Equals 1 if agent lives in urban and 0 if living in rural area	$\{0, 1\}$
s_i	Agent's number of encounters	-
$s_{min_{[urban]}}$	Minimum number of encounters; varies in *urban*	$s_{min_{[urban=0]}} = 0$
		$s_{min_{[urban=1]}} = 3$
$s_{max_{[urban]}}$	Maximum number of encounters; varies in *urban*	$s_{max_{[urban=0]}} = 4$
		$s_{max_{[urban=1]}} = 6$
m_{it}	Agent's strategy	(0,1)
λ	Weight of previous beliefs in the formation of new beliefs	0.3
δ	Weight of error term in forming new beliefs	0.2
$experience_{it-1}$	Agent's experience made in encounters; equals the share of cooperative agents that the agent faced in previous periods encounters	(0,1)
ϵ_{it-1}	Agent's individual error term	(0,1)
c	Cost for encounter	(0.4, 1.2)
x	Norm parameter for conformity	2
β	Degree of diminishing marginal utility of encounters	0.5
K-index	Incentive to cooperate	(0.91, 0.96)
potential migration rate	Share of agents who are able to change their location status per period	(0.01, 0.05)
number of players (N)	Number of agents	2000
number of rounds	Number of periods	1000

Table 4.5: Overview and linkage of variables and parameters which influence attributes of the system and steady state rates of participation and cooperation

Attributes of the system	**Influencing variables and parameters**
Steady state level of cooperation	Initial level of cooperative encounters, Adaptation of beliefs, Restrictions on the number of encounters
Initial level of cooperative encounters	Initial distribution of beliefs ($p_{i,0}$), Initial distribution of number of interactions, Distribution of loss aversion (α_i), Norm function ($f(p_{it}), g(p_{it})$), Payoff matrix / K-index,
Adaptation of beliefs	Influence of previous expectations (λ) and error term (δ) in forming new expectations, Initial distribution of number of interactions
Initial distribution of number of interactions	Cost of interaction (c), Payoff matrix / K-index, Norm function ($f(p_{it}), g(p_{it})$), Degree of decreasing marginal utility (β), Initial distribution of beliefs ($p_{i,0}$), Distribution of loss aversion (α_i),
Restriction on the number of encounters	Potential migration rate, Upper and lower bound for number of interactions

4.8.2 Pseudocode

The structure of the code and the style of the notation is freely adapted from Isaac (2008). The program for the simulation is written in *Python* in object-oriented code. Here, each agent is an *object* which bundles *data* (information) and *methods* (behavior). Objects get their *data* and *methods* from *classes*. Methods that are not defined in a body of a class are called *functions*. A function is therefore not agent-specific behavior but applies to all agents in the same way.

1. Functions

   a) Executed only once in period 0

      Generation of agents

      - generate agents
      - assign agents to be PlayerClass objects with information (payoff matrix, x, β, c, $s_{min_{[urban]}}$,$s_{max_{[urban]}}$) and behavior (*determine optimal s*, *determine strategy*, *determine migration decision*)
      - assign randomly initial values for $urban \in (0, 1)$, $\alpha \in (0, 0.5)$, $p_{i,0} \in (0, 1)$ for each agent

   b) Executed each round

      Random matching of agents

      - generate *list of agents* where each agent is s_{it}-times included
      - randomly match agents from *list of agents*
      - check if agents are matched with themselves; if this is true restart random matching, else continue
      - create list of randomly drawn agents who have the possibility to decide about migration (scope of list depends on *potential migration rate*)

2. Classes

a) PlayerClass (methods are executed each round for each agent)

- if round of games is not first round then p_{it} is updated: $p_{it} = \lambda \cdot p_{it-1} + \delta \cdot \epsilon_{it-1} + (1 - \lambda - \delta) \cdot experience_{it-1}$; if no experience was made in the last period ($s_{t-1} = 0$) then $experience_{t-1} = p_{it-1}$
- determine $EB_{it}(c)$ and $EB_{it}(d)$ according to Equation 4.16 and Equation 4.17
- determine strategy: if $EB_{it}(c) > EB_{it}(d)$ then $m_{it} = 1$, else $m_{it} = 0$
- if $\max\{EB_{it}(c), EB_{it}(d)\} > 0$ determine optimal s_{it} according to Equation 4.12
- optimal s_{it} is recorded as 'true s'
- if an agent is able to make a decision about migration, she will migrate from $urban = 1$ to $urban = 0$ if $s < s_{min_{[urban=1]}}$ and from $urban = 0$ to $urban = 1$ if $s_{it} > s_{max_{[urban=0]}}$
- if $s_{it} > s_{max_{[urban]}}$ then $s_{it} = s_{max_{[urban]}}$, if $s_{it} < s_{min_{[urban]}}$ then $s_{it} = s_{min_{[urban]}}$
- s_{it}, p_{it} and m_{it} are recorded
- s_{it} is passed on to RoundClass for matching players
- if $s_{it} > 0$ matched opponent(s) are requested from RoundClass
- strategy of opponents is evaluated and $experience_{it}$ (share of cooperative opponents) is recorded

b) RoundClass (methods are executed each round once)

- a 'round' starts
- s_{it} is requested from PlayerClass
- function that generates *list of agents* is called which comprises each player s_{it}-times

- function for matching players is called
- matched players list is returned to PlayerClass
- for data analysis: average values are created from agent data recorded in PlayerClass (overall, *urban*=0, *urban*=1): average s_{it} , average strategy chosen, average strategy played, share of agents with urban=1, average p_{it}, average expected benefit ($EB_{it}(c)/EB_{it}(d)$)
- a 'round' is ended

3. Sequence of simulation

- global parameter are requested: payoff matrix, x, β, c, $s_{min_{[urban]}}$,$s_{max_{[urban]}}$, β, c, λ, δ, number of players, number of rounds, potential migration rate
- function for generating players is called using 'number of players' and global parameters
- function for drawing random values of $p_{i,0}$, α_i and $urban_{it}$ is called
- A RoundClass object is created
- RoundClass object executes a 'round' for 'number of rounds' times

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Selbständigkeitserklärung

Ich bezeuge durch meine Unterschrift, dass meine Angaben über die bei der Abfassung meiner Dissertation benutzten Hilfsmittel, über die mir zuteil gewordene Hilfe sowie über frühere Begutachtungen meiner Dissertation in jeder Hinsicht der Wahrheit entsprechen.

Berlin, 8. August 2014 Regina Kühne