



Ozge Dilaver (2015)

From Participants to Agents: Grounded Simulation as a Mixed-Method Research Design

Journal of Artificial Societies and Social Simulation 18 (1) 15

<<http://jasss.soc.surrey.ac.uk/18/1/15.html>>

Received: 30-Oct-2013 Accepted: 04-Nov-2014 Published: 31-Jan-2015



Abstract

This paper introduces a mixed-method research design for investigating complexity of social reality. The research design integrates grounded theory (Glaser and Strauss, 1967) and social simulation and is therefore called *grounded simulation* (GS). GS starts with in-depth investigations of complex social phenomena from perspectives of people who experience them. These investigations follow principles of grounded theory and enquire into contexts that research participants describe and the way they make sense of action in these contexts. Data analysis progresses *inductively* and *outwards*, from narratives of people who are at the centre of the phenomena to emerging constructs and theories. While the grounded theory fieldwork would have its own research outputs, its selected findings can be then carried to agent-based models for further investigation of social complexity. By representing social and economic agents, their contexts and actions as closely as possible, GS shortens the distance between research participants, who have real life experiences of the subject being modelled, and the virtual agents. Knowledge production in social simulation progresses *generatively* and *upwards*, moving from interactions at the individual level to emergent properties at the macro-level. GS experiments are thus suitable for studying the societal implications of meanings that emerge from the data collected in grounded theory. The paper illustrates how this research design can be used, by referring to a GS study on diffusion of innovations.

Keywords:

Mixed Methods, Grounded Theory, Context, Rules, Fieldwork, Simulation Experiments



Introduction

- 1.1 Social simulation is a *generative* (Kohler 2000; Epstein 2006) or *constructive* (Tsfatsion 2006) research approach where the researcher builds a hypothetical reality with the simulation program that she or he writes. The emphasis put on agents and their interactions leads to *bottom-up* representations of social phenomena and establishes more *direct* (Gilbert 2008) *ontological correspondences* (Squazzoni 2010) between what is empirically observed and modelled compared to, for example, more conventional statistical models. At the same time, constructing an artificial world also brings about sets of assumptions that are necessary to *wrap up* different aspects of these worlds and produce behaviour of interest *in silico*. Through step-by-step decisions on what to include and exclude and which assumptions to make, social simulation researchers usually put together knowledge from different domains and construct detailed virtual realities.
- 1.2 These properties of social simulation models have some similarities with grounded theory (Glaser & Straus 1967) research that is *inductive* in nature. Grounded theory offers an alternative to *logico-deductive* type of reasoning for producing knowledge about social reality (Glaser & Straus 1967). Instead of taking general theories from the existing literature as the starting point and testing them through empirical studies, grounded theory research starts with narratives and stories of people who are at the core of the phenomena of interest and works *outwards* in producing knowledge, usually in the form of categories, relations and *middle-range* (Merton 1949), or *substantive theories* (Glaser & Straus 1967). The power of this research approach comes from remaining open to emergence of meaning – themes, constructs, theories – from data (Glaser 2013) as opposed to forcing data to presupposed schema.
- 1.3 Both social simulation and grounded theory empower researchers to build more direct – and so, interesting and useful – connections to social reality. In social simulation, being able to use computers beyond analytically tractable representations of

complex phenomena enables researchers to address issues such as bounded rationality and intentionality of agents, interdependencies between their actions, history-dependent social processes and their emergent society-level implications. In grounded theory, moving away from well-established constructs and angles of view enables researcher to explore new aspects of social phenomena and how they are made sense of by people who are experiencing them.

- 1.4 Both research approaches also empower researchers by lowering the entry barriers – at least more tangible and methods-related ones – to conduct research. In social simulation, although expressing arguments in algorithms in general, and in programming languages in particular, may still require some training and lengthy processes of trial-and-error, being able to construct hypothetical realities using relatively simple elements enable early career researchers to study and experiment with complex phenomena. Similarly, in grounded theory, the research process can be laborious and, analysing multiplicity of multifaceted stories can be demanding. Grounded theory researchers get better in *staying open* with training and experience. At the same time, in Glaser and Strauss's (1967) words, "*it does not take a 'genius' to generate a useful grounded theory*" (p.11). While in logico-deductive social science, theory building is left to fewer well-known scholars, or whom Glaser and Strauss's (p.11) call the "*theoretical capitalists*", in grounded theory, researchers can make important contributions to our theoretical knowledge of social reality with hard work dedicated to understanding data and discovering its various meanings.
- 1.5 These properties of social simulation and grounded theory that empower researchers, however, do not come without a cost. Flexibility and empowerment of individual researchers do not readily fit into *habits of thought* around systematic character of scientific research, and possibly also around how exclusively sophisticated scientific knowledge creation *should* be. Partly as a result of this misfit, both social simulation models and grounded theory research often receive scepticism, if not severe criticism, about whether or not their methods would accommodate *anything goes*. Some of the major reservations of both scholars within and outside the social simulation community have been related to where assumptions and decisions that shape a model come from and what exactly the researcher has done to come up with her or his way of abstraction, concepts, parameters, theories and models (see also Waldherr & Wijermans 2013). Similarly, misconceptions about grounded theory being a *no theory* or *no methods* research approach are quite common both within and outside researchers claiming to use grounded theory (see also Suddaby 2006).
- 1.6 In this paper, I follow the growing stream of studies that collect new qualitative data for informing their agent-based models (see Section III). More specifically, I integrate grounded theory and social simulation in a mixed-method research design that I call grounded simulation (GS). The overall aim of GS is to explore how research participants perceive and make sense of socio-economic contexts and actions, translate some of the findings into simulation models and observe their society-level implications.
- 1.7 GS uses the two research approaches in a complementary way. From the standpoint of social simulation, GS can establish a closer connection to the way various *rules of the game* are perceived and made sense of by individuals compared to more general theories, or *commonsense* of the researcher. From the standpoint of grounded theory, GS is a suitable way of applying principles of grounded theory for studying complex social phenomena. It enables extension of the research findings to higher levels, or new hypothesised contexts and thereby supports further theorising. The concept of *emergence* is central in both grounded theory and social simulation. In the former, the emphasis is put on emergence of meaning, in the form of themes and categories, from data. In the latter, it is the emergence of macro-level patterns, in particular counter-intuitive ones, from micro-level interactions. GS research integrates these two types of emergence in knowledge production.
- 1.8 Social simulation models are used to achieve a broad range of research objectives (Epstein 2008) and they can produce different types of knowledge claims. Similarly, collecting rich data and staying open to emergence of meanings in different research context may require active involvement of the researcher in the grounded theory research design and strategies. As GS consists of grounded theory and social simulation research, flexibility is likely to be one of its major strengths as well. Hence, it is not my aim in this paper to give a strict procedure that needs to be followed while conducting GS. Instead, I start by providing short but informative reviews of methodical components of GS in the next section. Then, I put these elements together in the third section, explain GS and how it can be used for investigating social complexity. In the fourth section, I illustrate the use of GS with a study on diffusion of innovations. Since social simulation is also regarded as an innovation (Squazzoni 2010), I think this study is informative both as an illustration and, albeit less directly, with its summarised content. I will conclude in the fifth section.



Elements and Methodological Foundations of Grounded Simulation

- 2.1 This section introduces the four methodical components of GS, which are: mixed-method research design, grounded theory, in-depth interviews and agent-based simulations. It is not possible to cover all of the useful information on these subjects in this paper. The section aims to provide a good starting point for readers from different methodological backgrounds by summarising what these methods and approaches are about, and pointing out some of the major methodological distinctions related to them.

Mixed-method Research

- 2.2 The term mixed-method commonly refers to employing both qualitative and quantitative methods (Johnson et al. 2007) in a research project and mixing in this context refers to "*the multifaceted procedures of combining, integrating, linking and employing multi-methods*" (Creswell et al. 2003, p. 212). While most authors regard mixed-methods as a research design strategy (Creswell & Plano Clark 2011), there are also others, who see it as a distinct methodology, or the "*third methodological movement*"

(Tashakkori & Teddlie 2003, p.ix).

- 2.3 Mixing of methods can occur within one study or throughout several studies in a research project or programme (Creswell 2003). The mixed-method design in which different types of data are collected in separate phases of research is called *sequential* (Creswell 2003) or *component* (Caracelli & Greene 1997) design and this is distinguished from *concurrent* (Creswell 2003) or *integrated* (Caracelli & Greene 1997) design in which different types of data are collected simultaneously.
- 2.4 The general aim of mixing methods is obtaining a better understanding of the phenomenon of interest than what qualitative or quantitative methods can provide on their own. Using both qualitative and quantitative methods can compensate for the weaknesses of each type of method, allowing both the perspectives of participants to be heard and comprehensive snapshots of the phenomena to be obtained. In their review of mixed-method studies, Greene and colleagues (1989) identified that such improved understandings can be useful for various purposes including: *triangulation* (comparing results from different methods studying the same phenomenon), *complementarity* (enhancing findings of one method with others), *development* (using the results of one method to develop and implement another), *initiation* (discovering contradictions that reframe research questions), or *expansion* (of the breadth and range of inquiry through new inquiries). In addition, mixed-method research often facilitates collaboration and exchanges between different research domains, providing a broader range of theories and frameworks for the study (Creswell & Plano Clark 2011).

Grounded Theory

- 2.5 Before introducing grounded theory, it may be useful to clarify that different streams of grounded theory emerged in time with disagreements on coding methods, whether or not literature review can be done before fieldwork and whether knowledge produced through grounded theory research is *discovered* or *constructed*. Interested readers can refer to reviews by Fernandez (2012) or Evans (2013) to learn more on these debates. In this section, I will stay closer to the original ideas in Glaser and Strauss (1967) that I found most useful for studying social complexity.
- 2.6 Glaser and Strauss (1967) define grounded theory as: "*discovery of theory from data systematically obtained from social research*" (p.2). This differs from conventional theory development and verification processes that are intentionally kept separate in modernist social science. Grounded theory research starts with views and perspectives of those who are at the core of the research subject and works *outwards* while analysing data, rather than starting with theories and constructs that may be developed outside and working *inwards* throughout the analyses (See Facer et al. 2001 for the borrowed terms of outwards and inwards).
- 2.7 As a method or research approach, grounded theory provides general principles and systematic but flexible guidelines. Delaying literature review until later stages of analysis, theoretical (or purposeful) sampling, recursive stages of data collection and analysis, and constant comparison of data units are among the distinguishing characteristics of grounded theory (Glaser 1992). Analysis in grounded theory starts with individual units of data. Abstract categories, which have a central role in explaining what data signify, *emerge* progressively from continuous comparisons of meanings in these units (Charmaz 2006). Later stages of data collection and analysis aim to produce *substantive theories*, which may consist of clear conceptual categories, descriptions of the properties of these categories and the relations between them. Given that data collection and analysis is a recursive process, "*published word is not the final one but only a pause in the never-ending process of generating theory*" (Glaser & Straus 1967, p.40). Although usefulness and fit-to-purpose are criteria to assess substantive theories (Glaser & Straus 1967), having these characteristics does not necessarily mean the theory is complete.
- 2.8 Not starting from existing theories and starting immediately with data collection does not mean that grounded theory research does not refer to the existing literature. Delaying the literature review to the later stages of research is a strategy used for not imposing pre-defined categories into the fieldwork data (Hickey 1997). Once the data "*has had the opportunity to direct the researcher*" (Evans 2013, p.44) to right directions and concepts, studies that are relevant for the concepts that emerge from the data can be selectively and discursively reviewed (Christiansen 2011). In this process, concepts coming from literature can be treated like yet another type of data (Glaser 2004) in the process of constant comparison. Literature review and comparison of emergent categories with concepts that exist in the literature are then used to locate the emergent substantive theory in the existing body of knowledge (Heath 2006).
- 2.9 In this regard, grounded theory offers a rich potential for interdisciplinary research although, in my view, this potential is not always fully exploited. Instead of well-established constructs that cut through social phenomena from certain familiar angles, grounded theory researchers have rich narratives with messy connections that may relate to different aspects of participants' lives. While comparing themes emerging from data with the existing literature, researchers may find it useful to refer to a broad range of studies in familiar as well as unfamiliar domains. GS research can be used to better exploit this quality of grounded theory by bringing in interdisciplinary habits of thought of complexity science.

In-depth Interview

- 2.10 In-depth interview is a frequently used qualitative research method that aims for obtaining what is commonly referred to as *rich* or *thick descriptions* of social reality. In-depth interviews allow participants to provide a more complete description of their perspectives (Patton 1990) and the researcher to explore unexpected findings. The underlying assumption of in-depth interviews is that individuals have important knowledge about the research subject, which can be accessed through an active questioning

and listening process (Hesse-Biber & Leavy 2006). In this method, the researcher allows the participants enough time to put together their narratives in issues that they see as important and relevant (Green & Thorogood 2004).

- 2.11 While Webb and Webb (1932, p130) define interview loosely as a "*conversation with a purpose*", Kvale (1996) very usefully points out some of the differences between interviews and daily conversations. Accordingly, an interview goes beyond casual exchange of information and becomes a careful questioning and listening process. In addition, an interview is not symmetrical like a casual conversation; the contextual expectation that the researcher will ask the questions gives the researcher a role to function and some control over the conversation.
- 2.12 Green and Thorogood (2004) provide other useful comparisons that reveal what in-depth interview is not. They compare a research interview with a job interview, a clinical history-taking and a police interrogation. The authors explain that unlike the job interview, a research interview does not aim to test the participants but rather to explore and compare their accounts for understanding the underlying structures. Unlike a health professional performing clinical history-taking, the researcher does not aim to narrow down participant's responses to information that is useful for diagnosis according to previous knowledge but rather, tries to open up the responses as much as possible without presumptions. Finally, unlike in a police interrogation, in a research interview existence of only one version of truth is not assumed. Instead, each participant's story is valid as his or her perspective of the phenomena of interest.
- 2.13 There are also epistemological considerations about in-depth interviews. Scholars debate on the extent to which knowledge is created during the interview as opposed to reflecting a prior reality, and the extent to which active participation of the researcher is desired. Kvale (1996) uses two metaphors to illustrate two perspectives related to these considerations: *interviewer as miner* or *traveller*. The first perspective is positivistic and it regards knowledge as given. As follows, truth is likened to some ore under ground and interviewing is an attempt to unearth it. The second perspective is constructionist and it regards knowledge as created. Interviewing, therefore, is a journey that collects narratives and impressions, and produces a story after returning home. Miller and Glassner (2004) argue that while positivistic view has been criticised (ironically) for not being realistic, the constructionist view that underlines knowledge is nothing more than researchers' narrative does not offer much for those who would like to learn about social phenomena through interviews. In contrast, the authors suggest that narratives come out of worlds that exist outside the interview and researchers are capable of capturing elements of this world through their study. In this respect, "*research cannot provide the mirror reflection of the social world that positivists strive for, but it may provide access to the meanings people attribute to their experiences and social worlds*" (p.126). Although the extent to which researchers will adopt the role of the *miner* as opposed to *traveller* may depend on their methodological backgrounds as well as the research questions they tackle, in my view, what interviews generally aim to achieve in GS research is accessing, albeit imperfectly, to meanings attributed by research participants to complex social phenomena that they experience.

Agent-Based Modeling

- 2.14 The last element of GS that I will introduce in this section is agent-based modelling and since the typical reader of JASSS is more than familiar with this research method, this is not an easy task. This brief introduction aims to slice down agent-based models from different angles, which may be a useful task for experienced modellers, while giving an idea of what agent-based modelling is about to other readers.
- 2.15 In essence, in agent-based modelling, the researchers generate virtual representatives of the concepts that jointly form the model, assign qualitative or mathematical properties to these entities, and define logical rules that constrain, shape or produce their behaviour and interactions. When compared to qualitative and quantitative research methods, agent-based modelling is relatively new and we often start making sense of innovations by first relating them to our existing mental schemas. Then, in time, we start making more detailed analyses of their functions and use-value (Dilaver 2013). In a similar vein, comparisons between social simulation (or computational social science) and more conventional research approaches have been parts and parcels of the scholarly attempts to make sense of this relatively new and innovative research route. It has been argued that simulations are the third type of symbol systems – differing from natural language and mathematics (Ostrom 1988) – and the third way of scientific reasoning – differing from induction and deduction (Axelrod 2005).
- 2.16 These arguments underline innovativeness of agent-based modelling in addressing questions about social phenomena. At the same time, agent-based modelling is similar to *business as usual* when it is reduced down to its *analytical elements*; the way researchers engage with it to construct knowledge. These elements include abstraction, reasoning, synthesis, experimentation and comparisons. Like other types of modelling, agent-based modelling brings about simplifications (Gilbert and Troitzsch 2005; Epstein 2006) of the perceived reality. The focus is usually on developing simple, but acceptably realistic and operationally complete representations of real-life processes. As this process may require synthesising otherwise separate units of knowledge, agent-based modelling facilitates systematic reasoning around the research topic. As the typical agent-based model accommodates a high number of different parameter settings, it enables researchers to experiment and compare multiple possibilities.
- 2.17 We can also think of conceptual anatomies of agent-based models and these can be useful in at least two ways. They can provide guidelines for developing models, and they can be used for understanding, communicating and comparing models. Regarding the former, Macal and North's (2006) step-by-step guidelines for building agent-based models distinguish between building the agents, the environment and the agent's behaviour (methods) and interactions. Regarding the latter, Bandini et al.

(2009) identify these concepts (environment, agents, interactions) as elements of an abstract and basic model that can be referred to while describing agent-based models. In my view, two more elements can be added to this conceptual anatomy for better understanding model structures: agents' relationships and the historicity of the model.

- 2.18 As the name implies, agents are at the core of analysis in this computational method. Agent-based models generate many independent and interacting virtual agents that are heterogeneous and of different kinds (classes). The environment the agents are placed in and interact with is the second major element of an agent-based model. The third conceptual element is the way behaviour and interactions of agents are envisaged. Agents' interactions can be with each other, with other classes of agents, or with the environment. The fourth element, agents' relationships, is often defined in the model via a social network structure. Finally, agent-based models may have implicit or explicit history-dependent processes, or connections between simulated events through changes in the simulated environment, agents' memory and learning, and evolution of networks between agents. Going over historicity in a model may enable us to understand emergent findings more easily.
- 2.19 Although there are likely to be baffling intersections between these elements in many models, the third element mentioned above, behaviour and interactions of agents, is often referred to as *rules* or *behavioural rules* of the model in social simulation community. In my view, historicity of the model is also very closely associated with what is meant with *behavioural rules*. The remaining elements can be generally regarded as the *context* of the model. Empirical findings can be used for building better representations of both context and behavioural rules of agent-based models.



Grounded Simulation

- 3.1 This section puts together the elements that are introduced in the previous section – grounded theory, mixed-method research design, in-depth interviews and agent-based modelling – to form a research design for studying complex and dynamic social phenomena.

Background

- 3.2 Using qualitative data for building more realistic simulation models is now well established. Yang and Gilbert (2008) and Tubaro and Casilli (2010) explain how ethnographic data can inform and enrich agent-based models. There is also a growing literature on companion and participative modelling in the study of socio-ecological issues such as renewable resource management and land use. These studies start with an initial model that is used as a medium of interaction between researchers and stakeholders. Through iterative interactions, the model is developed and both researchers and stakeholders improve their knowledge about the subject (Barreteau et al. 2003).
- 3.3 The idea of using grounded theory research to produce realistic representations of social reality in agent-based models has also been proposed in the existing literature. In their study of the effects of social networks on workplace behaviour, Andrews and colleagues (2005) argue for the usefulness of grounded theory approach in developing multi-agent simulations. The authors use case studies to explore the impact of social networks on issues like recruitment of new employees and absenteeism, and simulate production processes of the firm assuming happiness of employees is one of the factors contributing to firm's profitability. This is an early attempt to combine grounded theory with simulation models and although the paper makes the argument for this general approach, it lacks clarity with respect to where grounded theory was applied and which elements of the model were representing empirical findings.
- 3.4 A more recent study that mixes grounded theory with simulation models is by Dal Forno and Merlone (2012). The study tackled a game-theoretic context from principal-agent literature that the authors previously studied and published; thereby, in my view, diverging from guidelines of grounded theory. The authors jointly analysed data collected by experiments with human participants and reports written by these participants about their motivations during experiments in order to identify typologies and strategies of players, which they later recreated with simulation experiments. This interesting study demonstrates an effective research design for better understanding how research participants act and interact under experiment settings of a given game-theoretic context. At the same time, it mixes grounded theory, or qualitative data, and simulations in a very specific way through experiments and it has limitations in identifying the *rules of the game* in real life contexts or where these rules may be coming from.
- 3.5 The GS research presented in the next section started in 2006 and the GS design presented in this paper is designed independently from these contributions. It is more general than Dal Forno and Merlone's (2012) experiment-based design and it employs grounded theory in the classical way. Hence, it can be used to understand what matters to people and what are the relevant aspects of a social setting. GS can also be used to obtain emic (Agar 2005) descriptions of *behavioural rules* and theorising further on these rules through simulation experiments.

What is Grounded Simulation?

- 3.6 The basic premise of GS is investigating perspectives and day-to-day experiences of individuals who are likely to have valuable information about the phenomenon of interest with a grounded theory fieldwork and then using selected findings on *contexts* and *behavioural rules* that emerge from the narratives of research participants in the construction of well-reasoned agent-based models.

3.7 In this regard, GS progresses in two directions while producing knowledge about social complexity; it first moves *outwards* and then *upwards*. The outward move corresponds to progressing from empirical data to concepts and categories as opposed to starting from theories and hypotheses and moving inwards to data for testing them. The in-out distinction in this respect separates things that occur within complex social phenomena from their abstractions by external observers. The upward move is more familiar to social simulation researchers and it refers to the progress of knowledge creation from the level of individuals to meso, or macro levels. Figure 1 below has two functions; first, it illustrates this two-steps progress of GS research and second, it touches upon the two ways the central concept of *emergence* is referred to in outwards and upwards progresses of grounded theory and complexity science. For improving the clarity of discussion in the paragraphs that follow, I will refer to these two types of emergence, *emergence type 1* and *type 2* respectively.

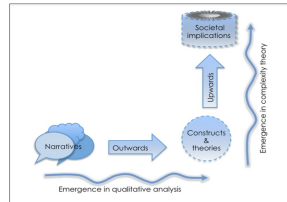


Figure 1. Outwards and upwards progress in GS

3.8 Although specific research designs and action plans may differ from project to project, the purpose of mixing in GS is closest to what Greene and colleagues (1989, see Section II) call *complementarity* and *development* purposes, as the in-depth interviews and agent-based models are used for studying overlapping but different aspects of the phenomena and the findings of the in-depth interviews are used to develop agent-based models. Moreover, GS is generally compatible with *sequential* (or component) design where, the findings of qualitative and quantitative studies can be reported independently (Creswell 2003), although the simulation study is likely to refer to the grounded theory study while explaining the modelling decisions and assumptions.

How to conduct GS

- 3.9 In this sub-section, I outline a basic GS design that is suitable for investigating social complexity as experienced in everyday life. In the interest of being succinct, I will not repeat information given in Section II about methodical components of GS but move on by describing how steps of GS can follow each other and providing practical suggestions for good research practice.
- 3.10 In line with general guidelines of grounded theory, GS research starts with data collection and it is good practice to start GS research by carefully considering groups of people who are likely to have direct experiences of the phenomena of interest. The design stage should also include choosing the sampling strategy that is suitable for the research objectives. Research interests of some projects may require focusing on particular groups, or comparing perspectives and experiences of two or more groups. In other projects, the aim is understanding different viewpoints around the topic. It is advantageous in this case to have the initial set of participants as mixed as possible with respect to issues that are likely to matter for the research subject. This will allow the researcher to explore a variety of perspectives and stories from early stages on.
- 3.11 In-depth interview is a suitable method of data-collection for GS due to its abovementioned properties. It would be useful to carefully consider the level of structure the interviews will have as part of the research design. While, very strict structures may restrict emergence of unexpected findings and so may not be very suitable for GS projects, asking a core set of open-ended questions to all participants may be useful to allow all of them to focus and reflect on the issue. Other questions may also be needed during interviews to clarify points that are not well understood or to follow up a topic that the participant brought about.
- 3.12 Interview questions in grounded theory fieldwork, in particular the core questions mentioned above, are essentially open-ended. They should be general enough to cover different types of experiences, and narrow enough to help participants find where to start. Some of these questions can lead to bases of comparison in the data analysis stage. Hence, wording questions in a way not to pass judgement on possible answers is important for being able to access meanings that participants attribute to various aspects of the topics being discussed. If a question involves values and preferences (advantages, difficult, harms, good), it is good practice to ask also the opposite version of the question (disadvantages, easy, benefits, bad) whenever possible. Neutrality of questions is also important for letting the participant experience through this property of the dialogue that it is truly him or her that is given a voice, whose experiences and views matter for the research. In my experience, this, together with attention and time allocated on participants' narratives, lead participants to open up and share more and have a more pleasant experience of participating in the research.
- 3.13 Analysis of the data is done inductively and through iterative stages. In-depth interviews can provide large amount of data covering both descriptions and explanations of social phenomena. Hence, reduction of data is an inseparable part of this method (Hesse-Biber & Leavy 2006). It is good practice to record and transcribe interviews. Transcriptions facilitate iterative analysis of data and allow researchers to use data analysis software in this process. Yet transcription of in-depth interviews may take considerable amount of time and small-scale projects may not afford to outsource this task. When transcription of full interviews is not feasible, listening to the audio records of all interviews and taking notes about units of meaning that are identified can be an alternative way of starting the analysis. When this is done a number of times, researcher can transcribe segments of narratives that are most informative. When interviews cannot be recorded, it is advisable to take notes and go over them immediately after

the interview while the dialogue is fresh in the memory.

- 3.14 Data analysis follows the grounded theory guidelines highlighted in the previous section, starting from open coding where units of meaning are identified and continuing with constant comparisons of different units of meaning, paying attention to staying open and not forcing data into presupposed categories.
- 3.15 Literature review is done after open coding and initial rounds of constant comparisons are complete. It is conducted in a selective and *transdisciplinary* way following concepts and categories that emerge from the data. This way of selective literature review offers an important potential for making synthetic contributions to the existing literature. After, or in addition to, making use of concepts and insights from the existing literature for better understanding the data, the researcher may refer to previous studies also for positioning the findings of his or her study in the literature. In this stage, it may be useful to clarify similarities, differences and connections between other empirical findings (of grounded theory studies as well as others) and what emerges from the fieldwork data.
- 3.16 Positioning the findings in the existing body of research also facilitates the writing-up of research outputs. The grounded theory fieldwork in GS can generate research outputs independent from the simulation models that follow. In fact, it is advisable not to be too concerned about the modelling stage before producing rough drafts of grounded theory research outputs for staying open to the emergence (type 1) of different kinds of findings from the data and not only issues that are more interesting to model.
- 3.17 The next stage in the GS design is the preparations for social simulation stage of the research. It is beneficial to reflect on the core findings of the grounded theory fieldwork at the beginning this stage. Researchers may find it productive to first spend some time on reviewing what is learned in the grounded theory fieldwork about the nature of the phenomena of interest and then allow themselves a creative phase where they think if these findings can be carried to agent-based models and envisage different representations. Creative ideas are in the habit of disappearing so keeping notes of different kinds (e.g. drawings, mind maps, metaphors and pictures of whiteboards) will be useful for not losing them forever.
- 3.18 GS modelling stage starts with turning these creative visions into more specific, and perhaps, multifunctional modelling ideas about representing conceptual elements of the agent-based model, namely *agents, environment, relationships, agents' behaviour and interactions, and historicity of the model*. Substantive theories that are produced through grounded theory fieldwork are likely to be informative both on contexts (agents, environment, relationships) and behavioural rules (agents' behaviour and interactions, historicity) of social simulation models. In simpler and more abstract models, representing only one type of information may suffice for developing useful and interesting models. As simple and abstract models are very suitable for generating and communicating emergence (type 2) of macro-level patterns, findings on new types of social and economic interactions may be particularly fruitful for focusing on for further investigation. For more detailed or case-study (Boero & Squazoni 2005) type of models, researchers may prefer to use all the available information and construct their *in silico* worlds similar to reality with respect to issues that emerge in grounded theory findings.
- 3.19 As part of developing modelling ideas, reviewing existing simulation models in the literature may be practical to identify similarities and differences between new findings and assumptions of the existing models. Researchers may decide to extend an existing model to different contexts or scenarios, they may add on to the level of detail an existing model has, improve some of the modelling assumptions with those informed by the grounded theory fieldwork, or choose to build an entirely different model that address the phenomena of interest in a novel way. This comparison would also help clarify more specific research objectives potential contributions of the GS model.
- 3.20 Construction of the model continues with choosing the agent-based software that will be used and transferring modelling ideas to algorithms and code. For novice modellers in particular, a good starting point for writing code is reviewing existing models in open-source model libraries. Coding process progress much faster if relevant modelling elements or methods can be found in existing models. Sometimes these pieces of code can be integrated in the newly built model. In other cases, just seeing how an algorithm works may be helpful for writing others. Simpler models or model components may be more useful in this regard as researchers can fully understand the code they are using. The use of another researchers' code can be acknowledged in model documentation and via usual rules of referencing in related research outputs. When the researcher is happy with her or his model as an abstraction of social complexity as reflected in grounded theory findings, the model can be used for exploring societal implications of these findings through experiments under different parameter and scenario settings.

Advantages of Grounded Simulation

- 3.21 GS purposefully combines inductive grounded theory fieldwork and simulation experiments around common research interests and complementary research questions. As mentioned in previous sections, it is argued in the existing literature that agent-based models provide a more direct correspondence between what is observed and modelled compared to statistical models. By shortening the distance between the research participants and the agents in simulation models GS improves content validity of agent-based models and provides an *even more direct correspondence*.
- 3.22 More specifically, shortening the distance between qualitative research participants and agents in simulation models is useful at least for two reasons. Firstly, it may help producing *more relevant* abstractions. Complex social phenomena often involves abundance of dynamic relationships, and reducing perceived reality to the elements that are most relevant for the research question in hand is an essential part of modelling. Models that are built based on literature may reflect well-reasoned and well-

known theoretical constructs. Yet, these constructs tend to be very general and they often reflect traditions of particular disciplines and fields. The GS model, as an integrated output of the research project is still a simplification of the phenomena of interest. Yet, it is a reflection of a different and potentially richer kind of abstraction that is used by real agents *inside* the phenomena of interest. By studying what is included or excluded in emerging themes and categories, researchers can get a sense of relevance and relative primacy of issues. Furthermore, while making sense of their experiences, participants relate various social contexts and events to each other. These perceived relations can transcend disciplinary boundaries in social science, providing the researcher a valuable opportunity to identify unexplored connections in her or his model. Since social simulation researchers are used to interdisciplinary work, they can exploit this potential for making significant contributions to existing literature.

- 3.23 Secondly, compared to using findings of existing qualitative studies, GS design enables researchers to address issues that matter for understanding complexity of social phenomena. Agent-based models are suitable for investigating evolutionary outcomes of social processes, spatial and geographical patterns, the role of social networks, interdependencies, learning and expectations. While these concepts and constructs are strongly embedded in the operation logic of complexity science, they may not necessarily be at the focus of the existing and/or independent qualitative studies, which may have initiated from other research domains with different objectives.
- 3.24 There is also a nice match between analytical elements and processes of grounded theory and social simulation. Although both research approaches are criticised for not being explicit and systematic enough, ironically, some of the core strengths of both social simulation (Epstein 2008) and grounded theory (Suddaby 2006) come from the fact that they are making otherwise tacit skills and processes of science such as abstraction, modelling, induction and theory building, relatively more explicit. In the same manner, GS does not provide strict but *instantly validating* procedures. On the contrary, researchers using GS will still have to explain and justify their methods-related decisions. What it provides are a basic design that can be modified, flexible guidelines that help researchers to make their own methods-related decisions more explicit, and some practical suggestions for becoming more prepared for peculiarities of their fieldwork.

Limitations of Grounded Simulation

- 3.25 GS design has some drawbacks as well as the abovementioned advantages for studying social complexity. Firstly, the research design should allow for adequate time for the grounded fieldwork and, more significantly, the laborious, inductive analysis of the fieldwork data. Secondly, most researchers are not trained both in qualitative research in grounded theory tradition and in simulation modelling. GS may require adoption of new research skills and/or collaborations between researchers who have necessary expertise. Although both acquiring of new skills and collaborations may be regarded as opportunities for development, there can be practical constraints especially for short time-spanned projects.
- 3.26 Furthermore, as one of the main guidelines of grounded theory is not forcing data into predefined categories to allow for *emergence* (type 1) of meaning from data, it is not possible at the beginning of the project to guarantee that the findings of the fieldwork will produce *emergence* (type 2) of counterintuitive macro-level patterns that enhances the impact of research outputs in complexity theory communities. That being said, against the background of the richness and high level of dynamism complex social processes involve, it is very likely that researchers can obtain useful and coherent understandings of these under-explored settings and construct novel and original simulation models by GS research. Thus, the focus on emergence type 2 should not close up researchers to discovery of other important findings.
- 3.27 Finally, one of the major drawback of GS design is also its major strength; producing original models that approach the phenomena of interest from unusual angles. Although such original models are likely to make significant contributions to our understanding of complex phenomena, in some cases, it may be more difficult to publish such novel models compared to ones that reflect well-known theoretical constructs, positioned closely to existing models and fitting into subject and methods foci of journals. If the relevance to daily experiences of complexity is captured nicely some of the reviewers will claim the core argument of the study is obvious and trivial. If, at the same time, it diverges from mainstream theory, others will find this core argument implausible. Hence GS research is likely to produce *Schrodinger's papers* that are both obvious and implausible at the same time (see also Waldherr & Wijermans 2013).



Illustration: A Grounded Simulation Model of Early Adoption Advantages During Diffusion of Innovations

- 4.1 This section illustrates the use of GS referring to the author's doctoral research project (Dilaver 2009) on consumer interdependencies during diffusion of innovations and touches upon on some further practical issues that were relevant to this project.

Background and Motivations

- 4.2 While the literature on diffusion of innovations is voluminous, expanding across decades and various disciplines including economics, sociology, marketing and communication studies, there is lack of interdisciplinary dialogue and understanding mechanisms of diffusion still remains to be one of the main research objectives in this multidisciplinary field.

- 4.3 The research project that is summarised in this section identified two important and interrelated gaps in the literature in particular. Firstly, diffusion studies have almost disappeared in sociology in the recent decades (see, for example, Ruttan 1996 for rural sociology) and research efforts have been mainly quantitative, focusing on temporal aspects of diffusion in other disciplines. The disappearance of qualitative diffusion studies left gaps in our knowledge about how individuals make sense of innovations and how exactly diffusion process is experienced in daily life. These gaps in the literature surfaced as well-known common biases in the field such as the pro-innovation bias, assuming all innovations are good for everyone, and consequently the individual-blame bias, the idea that non-adoption must be related to individuals' characteristics.
- 4.4 Secondly, in terms of explaining how diffusion occurs, theoretical approaches vary in different research streams. Following studies on diffusion of agricultural innovations in rural sociology (Ryan & Gross 1943; Rogers 1962), some researchers think of diffusion as a communication and imitation process (see, for example Bass 1969). Others, who are familiar with the diffusion studies in economics, regard diffusion as the cumulative result of rational decisions of individuals where costs and benefits of technology adoption improve in time (see probit approach in Stoneman 2002). In more recent studies, diffusion is seen as a complex process in which costs and/or benefits of adoption improve with the number of existing adopters and hence the adoption decisions of individuals are interdependent. Following the seminal studies of Granovetter (1978), Farrell and Saloner (1985) and Arthur (1989), many simulation studies assumed there were such *increasing returns* to adoption, showing that this effect can cause societies to lock-in to a particular technological trajectory. Despite growing interest on interdependencies during diffusion, however, scholarly attempts fall short of recognising different kinds of interdependencies, or even, clarifying whether or not increasing returns is the only type of interdependency that is relevant to the diffusion process.
- 4.5 The research project being summarised here aimed to address these gaps in the literature. It focused on interdependencies between adoption decisions of individuals and aimed to improve diffusion theories by studying the nature and everyday experiences of consumer interdependencies. One of the more specific research questions the project raised was whether or not *decreasing returns to adoption* was a significant part of diffusion process, or put simply, whether or not individuals recognised advantages of adopting innovations earlier than others. This issue was not raised in previous literature on diffusion.

Research Design

- 4.6 In this particular project, GS design was not first developed and then applied, but it emerged as a cumulative output of my methodological inquires and the integration of the methods that were necessary for tackling the research questions raised. Grounded theory was adopted as the general research strategy for the fieldwork on interdependencies mainly due to two reasons. Firstly, due to abovementioned lack of recent qualitative studies on inter-consumer diffusion of innovations, there wasn't a better starting point than the narratives of research participants. Secondly, the research project aimed to contribute to theory building and the inductive approach of grounded theory fits this research objective quite well. Social simulation was then the clear choice for exploring the society-level outcomes different types of interdependencies and understanding the diffusion process as a whole. This approach also followed existing game-theoretic and simulation studies on increasing returns to adoption. Hence, studying everyday experiences of consumer interdependencies with grounded theory and representing selected findings in agent-based simulation experiments emerged as an obvious but challenging mixed-method research design.
- 4.7 Figure 2 shows the main stages and elements of the GS design that was used in the project. The following subsections will introduce the fieldwork and agent-based simulation stages of the research in further detail and show how these stages were connected.

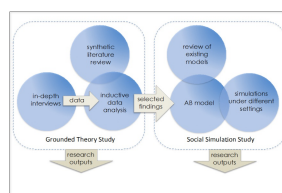


Figure 2. Research design of the diffusion study

Grounded Theory Fieldwork on Diffusion of Mobile Phones and Computers

- 4.8 As indicated above, the fieldwork of the GS study on diffusion aimed to investigate how adoption decisions of individuals were influenced by adoption decision of others and the diffusion level in the society in general. Selection of innovations that will be studied was done via a simple strategy that aimed to benefit as much as possible from *constant comparisons* technique that is used in data analysis in grounded theory. Accordingly, it was aimed to compare a rapidly diffusing innovation with a relatively slow diffusing innovation, and mobile phones and computers were identified as rapid and slow diffusing innovations respectively based on country-level surveys.
- 4.9 Maximum-variation sampling strategy (Patton 1990; Maykut & Morehouse 1994) was adopted to select research participants. This strategy involves selecting persons or settings that represent the greatest differences in relevant characteristics in order to obtain the broadest range of information. The recruitment of participants was done using the snowball technique and as the number of participants increased individuals who were different from the earlier participants in terms of gender, income, age and education were prioritised. Saturation with regards to the content of responses was reached after interviewing 48 participants.

- 4.10 The data collection method was in-depth interviews. Although my main interests were about interdependencies, I started interviews with more general questions about what computers and mobile phones mean to participants. In my experience with this and other research projects, asking what some key concepts mean to participants is a good way of starting interviews as it enables participants to focus on these concepts, and in some cases explore their various meanings as they speak. Discussions also covered perceived benefits and harms of these innovations and whether it was easy or difficult to purchase and use them.
- 4.11 With regards to investigating interdependencies between decisions of individuals, there were two major practical difficulties. Firstly, *interdependency* is not an everyday concept that is meaningful for everyone. For addressing this problem, interview questions focused on the *order of adoption* and inquired whether adopting earlier or later than others in one's social environment had any meanings or importance for the research participants. Secondly, as interdependent (in particular imitative) behaviour is often caricaturised and being able to make one's decisions on one's own is valued in popular modernist discourses of rationality, some participants felt uncomfortable about being asked whether or not their adoption decisions were influenced by others. For overcoming this problem, participants were not directly asked about their own decisions. Instead the questions were directed at participants' observations about others in their social environment and some participants then referred to themselves if they wanted to.
- 4.12 Data analysis was done inductively starting with open coding. All the narratives concerning what adopting personal computers and mobile phones earlier or later than others mean for the participants were broken into units of meaning (Strauss & Corbin 1990), which were then grouped under themes, constantly comparing different themes with each other. In line with the guidelines of grounded theory (Glaser & Strauss 1967; Patton 1990), the literature review was not done before the fieldwork in order not to impose pre-defined structures during the collection of the data. Instead it was undertaken simultaneously whilst analysing the data, guided by the initial findings.
- 4.13 Constant comparisons of data on personal computers and mobile phones and synthetic literature review of constructs developed in diffusion of innovations, cognitive psychology and marketing literatures yielded insights about how individuals make sense of innovations in the first place (Dilaver 2013). With respect to interdependencies, the findings of the fieldwork showed that the participants recognised various motivations for adopting innovations earlier than others, and so they found early adoption advantages (EAA) relevant and familiar. This finding was important because EAA are instances of decreasing returns to adoption and recent literature on interdependencies during diffusion is predominantly about increasing returns. Few short narratives are given below for giving the reader a feeling of what experiences of participants about early adoption were like.

Participant 15: When we (I) put the first computer it was quite a bombshell... Later other offices started to be found... At that period, you know we became quite of a star, we shone. However, when the computer prices started to drop... all publishers started to purchase a computer of their own, and started to do these tasks within the firm. At the moment, almost all publishers do it internally. There are hardly any design offices left.

Participant 47: At that time, the department of graphics was very new in this city. The students graduated from us were able to find jobs very easily at that time... They learned those programs earlier than others; they have become different and more preferable.

Participant 6: Seeing someone using a laptop in the university library used to impress me. Then, everybody started to buy one, but I realised that their purpose for working there was not genuine. I mean, they all type some stuff with Word. How much work can you have with Word?

- 4.14 Beyond confirming that the EAA exist, the fieldwork identified different types and contexts of EAA which were then, in later stages of data analysis, organised under two main categories; consumption-related and productive EAA. Regarding the former, although that consumption is not only a means of satisfying individual needs in an atomistic manner, but also used strategically for signalling wealth and hence status with respect to the rest of the society is known at least since Veblen (1899) and Simmel (1904), this form of interaction hasn't been addressed in studies of diffusion, or more generally related to social complexity. Regarding the latter, importance of innovativeness is well established for firms and advantages of early adoption of innovations is demonstrated in Reinganum's (1981) game theoretic analysis. It was, however, not pointed out that individuals also use technology for improving their productive potentials and recognise adopting innovations earlier than others is a strategic motivation in this context.
- 4.15 The grounded theory fieldwork revealed that competitions of different sorts between the society members are at the core of the participants' stories on EAA. In effect, the reason why adopting earlier than others was relevant and important, was that new technologies were used in these on-going competitions for better jobs, status and claimed identities. In this respect, the study revealed that there isn't necessarily a straightforward correspondence between the use-value of innovations at the individual and society levels. More specifically, at the individual level, innovations involved re-allocation of existing values in the society (e.g. better jobs, higher status, desired characteristics) by giving adopters advantages in various competitions in addition to the additional use-value they brought about (e.g. accessing information, communication).

Agent-based Model of Consumer Interdependencies during Diffusion

- 4.16 The simulation part of the GS project studied societal outcomes of consumer interdependencies during diffusion. An agent-based

model called Four Gears that focuses on interdependencies between adoption decisions was built for this purpose and it was used for running a high number of computational thought experiments. The model was intentionally kept simple so that the simulation results, which were not known prior to the simulation experiments, could easily be traced back. This sub-section briefly introduces the agent-based model, explains how the fieldwork findings described above were transferred to the properties of the model and illustrates how the model was used for further analysis of these findings. Although the agent-based model covered a broader range of diffusion contexts and interdependencies, in this subsection, in the interest of keeping discussions to the point, I will follow on the previous subsection and focus on the simulation experiments about EAA to address the level of control consumers have in diffusion of technologies (Dilaver 2014).

- 4.17 The model has a simplistic context. Agents represent consumers and a pseudo-society consists of 1,000 agents. Since social and economic factors, as well as competition between society members are influential in adoption of new technologies, relationships of agents are modeled as an abstraction of social class structures. Accordingly, agents are heterogeneous with respect to an attribute called accumulated characteristics, which can be thought as the combined effect of human and financial capital. It is then assumed that social networks are built based on this attribute; agents choose their friends randomly from a range of agents around themselves in the rank of accumulated characteristics. Institutions, which can be in conformity or conflict with the innovation, are modelled on top of this social network structure. Agents decide on whether or not to adopt an innovation with limited product life in this context. If they adopt, they remain adopters till the end of product life. If they don't adopt, or when the product life is over, they make a new adoption decision in the next period.
- 4.18 More detailed behavioural rules of the model reflect findings of the grounded theory fieldwork and they represent interdependent adoption decisions of agents. More specifically, the adoption decisions of agents are modelled as cost-value comparisons, where the use-value agents can create with the innovation depends on the number of adopters in the pseudo-society. Thus, in order to assess how much value they can create with the innovation, agents need to build expectations of what the diffusion level in their social environment will be. They build these expectations adaptively based on their local observations of the adoption status of agents they know. Function 1 below is the rule for building diffusion expectations, where N_{ikt} stands for the level of diffusion of innovation k in agent i 's social environment at time t , E_{ikt} stands for expectations of agent i , and a_{ikt} is the growth in diffusion levels compared to previous periods.

$$E_{it}(N_{ikt+1}) = N_{ikt} + a_{ikt} * (100 - N_{ikt}) \quad (1)$$

- 4.19 Figure 3 below demonstrates the general flow of simulated events. More specific findings of the grounded theory fieldwork are reflected to the mathematical properties of the model via the forms of the decision rule functions. As reported in the previous subsection, it was identified in the fieldwork that competitions between society members was the underlying reason for EAA. Furthermore, it was reflected upon research participants' stories that the advantages early adopters gain mostly corresponded to re-allocation of existing values in the society. Translation of these findings to mathematical properties of the model was done in two steps, in Functions 2 and 3 below.

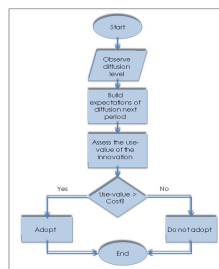


Figure 3. Main algorithm of the model

- 4.20 First, EAA was modelled as part of expected use-value of the innovation, yielding higher value to agents if they adopt it earlier than others. In Function 2, β_k stands for the maximum use-value an agent can create with the innovation due to EAA. As it can be seen in the function, the expected use-value of the innovation k for agent i (noted as $E_{it}(V_{ikt+1})$ in the function), is highest when there are no other adopters. As the number of adopters increase, the use-value of the innovation goes down at a decreasing rate.

$$E_{it}(V_{ikt+1}) = \beta_k / [E_{it}(N_{ikt+1}) + 1] \quad (2)$$

- 4.21 Secondly, that the use-value of innovations at the individual level may differ from the use-value at the society level and may correspond to losses of other society members was reflected in the model through a constant-sum game setting. A constant-sum game setting is different from a variable-sum game in that the sum of all players' payoffs is the same for any combination of strategies. Hence, a gain for one player corresponds to the loss of others. In Function 3 below, the adoption decision does not only depend on the expected use value of innovation ($E_{it}(V_{ikt+1})$), but also on the expected cost of non-adoption, which the agents assess by dividing the total use-value of expected number of adopters by expected number of non-adopters.

$$\text{adopt if } E_{it}(V_{ikt+1}) + [E_{it}(V_{ikt+1}) * E_{it}(N_{ikt+1})] / E_{it}(N_{ikt+1}) > C_k \quad (3)$$

- 4.22 In order to study societal effects of this property of EAAs, the simulation experiments covered both variable and constant-sum early adoption advantages. A total of 6,000 simulation experiments were run under different scenarios and parameter values. Figure 4a and b both show the results of multiple rounds of experiments. The x-axis in the figures show the technical potential of the innovation; in both scenarios when the technical potential is very low no adoption occurs. The z-axis shows the time during the experiments and the y-axis is the diffusion level.
- 4.23 Simulation findings revealed that when early adoption advantages are in the form of variable-sum games, diffusion outcomes at the macro level follow oscillating patterns like in Figure 4a. The y-axis of the figure shows the level of diffusion, the x-axis corresponds to experiments with different β_k values and z-axis corresponds to time in simulation experiments. This oscillation occurs because the expectations about diffusion are built adaptively. In the first period, all agents expect that the diffusion will be low and so their EAA will be high enough for them to adopt. In the next period, however, they see that the actual diffusion level is very high; all agents are adopters. This means they are not creating any use-value with the innovation at all. When the end of the product life comes, expecting the future diffusion levels will continue to be high, they cease adoption.

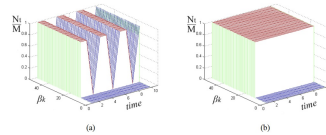


Figure 4. (a) Variable-sum EAA. (b) Constant-sum EAA.

- 4.24 More interestingly, when the innovation entails constant-sum early adoption advantages, the society locks-in to the innovation as shown in Figure 4b. That is, at first, like in the variable-sum scenario, all agents adopt expecting that the diffusion levels to be low and their use-value will be high. When they realise that actual diffusion levels are high, on the other hand, they do not cease adoption as in the previous scenario. This is because if they cease adoption, they may be one of the few non-adopters who need to bear the loss corresponding to the early adoption advantages of adopters. Hence, they continue adopting the innovation, albeit not happily.
- 4.25 This demonstrates an interesting possible outcome of consumer interdependencies: involuntary technology adoptions. That is; for some society members, adoption is a worse state than their initial state before the launch of the innovation. Once the innovation is launched and some adoptions occur, however, non-adoption becomes an even worse state. The major implication of involuntary technology adoption is the possibility that a society *locks-in* to inefficient, partially harmful or destructive technologies that entail this particular form of consumer interdependency.

Conclusions

- 4.26 This paper introduces GS, a mixed-method research design that integrates and supports the *generative* and *bottom-up* nature of social simulation research with the *inductive* and *inside-out* approach of grounded theory. Hence, GS extends mixed-method research in a way to cover computational methods.
- 4.27 The paper suggests in-depth interviews can be mixed with agent-based models for studying complex social phenomena. In this way of mixing methods, GS research starts by collecting data on the ways research participants make sense of their social contexts and experience conditions and causalities that shape their behaviour. Selected findings emerging from the fieldwork data are then translated to logical and mathematical elements of the agent-based model with the aim of investigating their society level implications under different scenarios and settings. In this respect, GS research progresses in two directions while producing knowledge of complex social phenomena; it first move *outwards* from perspectives and experiences of people who are at the centre of the phenomena of interest and then *upwards* from individual to society level.
- 4.28 GS research offers several strengths for investigating complex social phenomena by providing an *even more direct correspondence* between the phenomena of interest and its representations than more conventional agent-based models that are based on the modellers' perspectives or common sense, existing or independent qualitative evidence, or literature reviews. Compared to models that are built based on the modeller's own worldview or commonsense, GS is likely to deliver more realistic or relevant models by giving voice to more than one person and to those who are more directly involved in the processes, issues and problems the modeller aims to address.
- 4.29 Although GS research follows on studies that inform social simulation models with qualitative evidence, compared to models that are based on existing or independent qualitative studies, GS models have the advantage of being able to focus on those issues that are at the core of social complexity during the fieldwork stage and thus *shortening the distance* between the qualitative and computational studies. While issues such as interactions and interdependencies between social and economic agents are more likely to inform agent-based models of social complexity, existing or independent qualitative studies of the phenomenon of interest may initiate from different fields, concerns and questions. By purposefully combining inductive grounded theory fieldwork with simulation experiments GS enables researchers to obtain a deeper understanding of settings and interactions that shape and reproduce social complexity, before exploring societal impact of these observations with agent-based models.
- 4.30 GS design both has advantages and disadvantages compared to models built on extensive literature review. It may fall short of referring to all theoretical arguments in the existing literature in all their depth, richness and conceptual aesthetics but in cases

where path-dependent development of academic literature diverges from the fundamental properties of the continuously evolving and complex social realities, GS has the advantage of breaking the path and making a fresh yet well grounded start.

- 4.31 Both social simulation models and grounded theory research often receive criticism for not being systematic enough and scepticism about where assumptions they make or conceptual constructs they build come from. It is indeed important to report research methods employed and decisions that are made during the research process as transparently as possible in any research output. At the same time, there is an element of irony related with abovementioned concerns about social simulation and grounded theory. Some of the core strengths of both social simulation (Epstein 2008) and grounded theory (Suddaby 2006) come from the fact that they are making otherwise tacit skills and processes of science namely, abstraction, modelling, induction and theory building, relatively more explicit. As Epstein (2008) pointed out, anyone who is imagining or reasoning about a social process make use of implicit models with sets or systems of assumptions. Part of building social simulation models is making these models explicit, so that they can be discussed and developed. Similarly, the problems related with induction are well known and have long been debated in philosophy. Both researchers working with conventional and novel methods face these problems while building theories. Grounded theory's contribution has been providing practical guidelines for starting from data and moving inductively outwards for producing substantive theories.
- 4.32 In the same vein, GS and the flexible guidelines provided in this paper clarify otherwise more tacit processes of investigating complex social phenomena. By both referring to methodological background and practicalities related to mixing grounded theory and social simulation, the paper encourages interested researchers to assess relative strengths and weaknesses of different research methods, explore types of knowledge claims these methods can produce and design mixed-method research projects that serves their objectives in the best way possible.



References

- AGAR, M. (2005) Agents in Living Color: Towards Emic Agent-Based Models, *Journal of Artificial Societies and Social Simulation*, 8 (1) 4: <<http://jasss.soc.surrey.ac.uk/8/1/4.html>>
- ANDREWS, C. J., Baptista, A. I. & Patton, S. (2005) Grounded Theory and Multi-agent Simulation for a Small Firm, in Terano, T., Kita, H., Kenada, T., Arai, K., and Deguchi, H. (eds) *Agent-Based Simulation: From Modeling Methodologies to Real-World Applications*, Tokyo: Springer-Berlag. [doi:10.1007/4-431-26925-8_16]
- ARTHUR, W. B. (1989) Competing Technologies, Increasing Returns, and Lock-in by Historical Events, *Economic Journal*, 99(394), 116–31. [doi:10.2307/2234208]
- AXELROD, R. (2005) Advancing the Art of Simulation in the Social Sciences, in RENNARD, J-P. (ed.) *Handbook of Research on Nature Inspired Computing for Economy and Management*, Hersey, PA: Idea Group.
- BANDINI, S., Manzoni, S. & Vizzari, G. (2009) Agent Based Modelling and Simulation: An Informatics Perspective, *Journal of Artificial Societies and Social Simulation*, 12 (4) 4: <<http://jasss.soc.surrey.ac.uk/12/4/4.html>>
- BARRETEAU, O., Antona, M., D'Aquino, P., Aubert, S., Bousquet, F., Dare, W., Etienne, M., Le Page, C., Mathevet, R., Trebill, G. & Weber, J. (2003) Our Companion Modelling Approach, *Journal of Artificial Societies and Social Simulation*, 6 (2) 1: <<http://jasss.soc.surrey.ac.uk/6/2/1.html>>
- BASS, F.M. (1969) The New Product Growth For Model Consumer Durables, *Management Science*, 15(5), 215–227. [doi:10.1287/mnsc.15.5.215]
- BOERO, R. & Squazzoni, F. (2005) Does Empirical Embeddedness Matter? Methodological Issues on Agent-Based Models for Analytical Social Science, *Journal of Artificial Societies and Social Simulation*, 8 (4) 6: <<http://jasss.soc.surrey.ac.uk/8/4/6.html>>
- CARACELLI, V. J. & Greene, J. C. (1997) Crafting mixed-method evaluation design, in Greene, J.C. & Caracelli, V. J. (eds.), *Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms*[New Directions for Program Evaluation No. 74], San Francisco: Jossey-Bass, 19–32. [doi:10.1002/ev.1069]
- CHARMAZ, K. (2006) *Constructing grounded theory: a practical guide through qualitative analysis*, London: Sage.
- CHRISTIANSEN, O. (2011) The Literature Review in Classic Grounded Theory Studies: A methodological note, *The Grounded Theory Review*, 10(3), 21–25.
- CRESWELL, J. W. (2003) *Research Design: Qualitative, Quantitative, and Mixed Method Approaches*, Thousand Oaks, London and New Delhi: Sage.
- CRESWELL, J. W., & Plano Clark, V. L. (2011) *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks, CA: Sage.
- CRESWELL, J. W., Plano Clark, V. L., Gutmann, M. L. & Hanson, W. E. (2003) Advanced Mixed Methods Research Designs, in Tashakkori, A. & Teddlie, C. *Handbook of mixed methods in social & behavioral research*, Thousand Oaks, London and New

Delhi: Sage, 209–240.

DAL FORNO, A. & Merlone, U. (2012) Grounded Theory Based Agents, in Laroque, C., Himmelspace, J., Pasupathy, R., Rose, O. and Uhrmacher, A. M. (eds), *Proceedings of the 2012 Winter Simulation Conference*. [doi:10.1109/WSC.2012.6465064]

DILAVER, Ö. (2009) Competition and Co-operation: Four Studies on Consumer Interdependencies During Diffusion of Innovations, Unpublished PhD Thesis, Lancaster University.

DILAVER, Ö. (2013) Making sense of innovations: A comparison of personal computers and mobile phones, *New Media & Society*, forthcoming first published online on September 25, 2013.

DILAVER, Ö. (2014) Involuntary technology adoptions: How consumer interdependencies lead to societal change, *Structural Change and Economic Dynamics*, 31, 138–148. [doi:10.1016/j.strueco.2014.09.003]

EPSTEIN, J. M. (2006) *Generative Social Science: Studies in Agent-based Computational Modeling*, Princeton, Oxford: Princeton University Press.

EPSTEIN, J. M. (2008). Why Model?. *Journal of Artificial Societies and Social Simulation*, 11(4) 12: <<http://jasss.soc.surrey.ac.uk/11/4/12.html>>

EVANS, G. L. (2013) A Novice Researcher's First Walk Through the Maze of Grounded Theory: Rationalization for Classical Grounded Theory, *Grounded Theory Review*, 12(1), Retrieved from <http://groundedtheoryreview.com/2013/06/22/a-novice-researchers-first-walk-through-the-maze-of-grounded-theory-rationalization-for-classical-grounded-theory/> on 12.03.2014.

FACER, K., Sutherland, R., Furlong, R., & Furlong J (2001) What is the point of using computers?: The development of young people's computer expertise in the home.

FARRELL, J. & Saloner, G. (1985) Standardization, Compatibility, and Innovation, *The Rand Journal of Economics*, 16(1), 70–83. [doi:10.2307/2555589]

FERNANDEZ, C. (2012). Guest Editorial, Themed Section. The Grounded Theory Review, 11(1), Retrieved from <http://groundedtheoryreview.com/2012/06/01/guest-editorial-themed-section/> on 12.03.2014.

GILBERT, N. (2008) *Agent-Based Models*, London: Sage.

GILBERT, N. & Troitzsch, K. G (2005) *Simulation for the Social Scientist*, Buckingham and Philadelphia, PA: Open University Press.

GLASER, B. G. (1992) *Emergence vs Forcing: Basics of Grounded Theory Analysis*, Mill Valley, CA: Sociology Press.

GLASER, B. G. (2004) Remodeling Grounded Theory, *Grounded Theory Review*, 4(1), retrieved from <http://groundedtheoryreview.com/2004/11/30/1612/> on 12.03.2014.

GLASER, B. G. (2013) Staying Open: The Use of Theoretical Codes in Grounded Theory, *The Grounded Theory Review*, 12(1), http://groundedtheoryreview.com/wp-content/uploads/2013/06/Vol12Issue1_GlaserTheoreticalCodes.pdf

GLASER B. G. & Strauss, A. L. (1967) *The discovery of grounded theory: strategies for qualitative research*, Chicago: Aldine.

GRANOVETTER, M. (1978) Threshold Models of Collective Behavior, *American Journal of Sociology*, 83(6), 1420–1443. [doi:10.1086/226707]

GREEN, J. & Thorogood, N. (2004) *Qualitative Methods for Health Research*, London: Sage.

GREENE, J. C., Caracelli, V. J. & Graham, W. F. (1989) Toward a Conceptual Framework for Mixed-Method Evaluation Designs, *Educational Evaluation and Policy Analysis*, 11(3), 255–74. [doi:10.3102/01623737011003255]

HEATH, H. (2006) Exploring the Influences and Use of the Literature During a Grounded Theory Study, *Journal of Research in Nursing*, 11(6), 519–528. [doi:10.1177/1744987106069338]

HESSE-BIBER, S. N. & Leavy, P. (2006) *The Practice of Qualitative Research*, Thousand Oaks, CA: Sage.

HICKEY, G. (1997) The Use of Literature in Grounded Theory, *Journal of Research in Nursing*, 19(5), 371–378. [doi:10.1177/174498719700200510]

JOHNSON, R. B., Onwuegbuzie, A. J. & Turner, L. A. (2007) Toward a Definition of Mixed Method Research, *Journal of Mixed Method Research*, 1(2), 112–33. [doi:10.1177/1558689806298224]

KOHLER, T. A. (2000) Putting social sciences together again: An introduction to the volume, in *Dynamics in Human and Primate Societies: Agent-based Modeling of Social and Spatial Processes* (0-19-513168-1, 978-0-19-513168-0), (p. 1).

KVALE, S. (1996) *Interviews: An Introduction to Qualitative Research Interviewing*, Thousand Oaks, CA: Sage.

MACAL, C. M. & North M. J. (2006) Tutorial on AB Modeling and Simulation Part 2: How to Model with Agents, in Perrone, L. F.,

- Wieland, F. P., Liu J., Lawson, B. G., Nicol, D. M. & Fujimoto, R. M. (eds.), *Proceedings of the 2006 Winter Simulation Conference*. [doi:10.1109/WSC.2006.323040]
- MAYKUT, P. & Morehouse, R. (1994) *Beginning Qualitative Research: A Philosophic and Practical Guide*, London: The Falmer Press.
- MERTON, R. K., (1968 [1949]) *Social theory and social structure*, New York: Free Press.
- MILLER, J. & Glasner, B. (2004) The 'Inside' and the 'Outside': Finding Realities in Interviews, in Silverman, D. (eds), *Qualitative Research: Theory, Method and Practice*, London: Sage.
- OSTROM, T. M. (1988) Computer Simulation: The Third Symbol System, *Journal of Experimental Social Psychology*, 24(5), 381–392. [doi:10.1016/0022-1031(88)90027-3]
- PATTON, M. Q. (1990) *Qualitative evaluation and research methods*, Newbury Park, CA: Sage.
- REINGANUM, J. (1981) On the diffusion of new technology: A game theoretic approach, *Review of Economic Studies*, 48(3), 395–405. [doi:10.2307/2297153]
- ROGERS, E. M. (1995 [1962]) *Diffusion of Innovations*, New York: Free Press.
- RUTTAN, V. W. (1996) What Happened to Technology Adoption-Diffusion Research, *Sociologia Ruralis*, 36(1), 51–73. [doi:10.1111/j.1467-9523.1996.tb00004.x]
- RYAN, B. & Gross, N. C. (1943) The Diffusion of Hybrid Seed Corn in Two Iowa Communities, *Rural Sociology*, 8(1), 15–24.
- SIMMEL, G. (1904 [1957]) Fashion, *The American Journal of Sociology*, 62(6), 541–58. [doi:10.1086/222102]
- SQUAZZONI, F. (2010) The Impact of Agent-based Models in the Social Sciences after 15 Years of Incursions, *History of Economic Ideas*, XVIII, 2, 197–233.
- STONEMAN, P. (2002) *The Economics of Technological Diffusion*, Oxford: Blackwell Publishers Ltd.
- STRAUSS, A. L. & CORBIN J. (1990) *Basics of qualitative research: Grounded Theory Procedures and Techniques*, Newbury Park: Sage.
- SUDDABY, R. (2006) From The Editors: What Grounded Theory Is Not, *Academy of Management Journal*, 49(4), 633–42.
- TASHAKKORI, A. & Teddlie, C. (2003) *Handbook of Mixed Methods in Social and Behavioral Research*, Sage: Thousand Oaks, C.A.
- TESFATSION, L. (2006) Agent-based Computational Economics: A Constructive Approach to Economic Theory, *Computing in Economics and Finance 2006* 527, Society for Computational Economics. [doi:10.1016/s1574-0021(05)02016-2]
- TUBARO, P. & Casilli, A. A. (2010) An Ethnographic Seduction: How Qualitative Research and Agent-based Models can Benefit Each Other, *Bulletin de Methodologie Sociologique*, 106(01) 1–16. [doi:10.1177/0759106309360111]
- VEBLEN, T. B. (1899 [1961]) *The Theory of The Leisure Class: An Economic Study of Institutions*, New York: The Modern Library.
- WALDHERR, A. & Wijermans, N. (2013) Communicating Social Simulation Models to Sceptical Minds, *Journal of Artificial Societies and Social Simulation*, 16 (4) 13: <<http://jasss.soc.surrey.ac.uk/16/4/13.html>>
- WEBB, S. & Webb, B. (1932) *Methods of Social Study*, London and New York: Longmans, Green.
- YANG, L. & Gilbert, N. (2008) Getting Away From Numbers: Using Qualitative Observation For Agent-Based Modelling, *Advances in Complex Systems*, 11(2), 175–185. [doi:10.1142/S0219525908001556]