Epistemic Communities in Urban Self-organization: A Systematic Review and Assessment

Ewald de Bruijn¹ and Lasse Gerrits²

Abstract
The application of the concept of self-organization has grown over time in the field of urban planning, but with various interpretations. This article presents a systematic review that aims to uncover whether different uses of self-organization are tied to epistemic communities. Through coding and bibliographical analysis, it became apparent that there are two epistemic communities that emphasize different conceptualizations of self-organization. They investigate different issues, use different methods, and find different results. At the one hand, authors use self-organization in modeling approaches, particularly revolving around topics such as economic geography and urban growth. At the other hand, authors use self-organization as surrogate for self-governance, often studied with qualitative methods.

Keywords
governance, self-organization, spatial analysis and models, epistemic communities, systematic review

Introduction and Motive
The concept of self-organization is gaining considerable traction in scientific work about urban and regional planning (see Figure 1). Outside of mere numerical proof, which is possible confounded by an overall increase in scientific output, the importance of self-organization in our discipline has been highlighted by other authors (Boonstra and Boelens 2011; Portugali 2011). There are roughly three reasons for this increased attention. First, it provides an explanans for the emergence of spatial patterns over long periods of time without any superimposed design or the emergence of spatial patterns that were not intended (Batty 2007; Moroni 2015). Second, it provides an attractive alternative planning approach for governments that—in this time and age—lack the resources to fulfill all societal wishes (Sørensen and Torfing 2016) or wish to foster participation (Jun 2007). Third, it ties in with established criticism against modernist planning methods with their focus on expert-driven, authority-based spatial plans as opposed to citizen-driven, bottom-up initiatives (De Roo 2012).

While there is both a strong normative, liberal undercurrent and a healthy dose of pragmatism in the current public debate about self-organization, there is also a genuine realization that self-organization in the broadest sense of the word is a crucial factor in understanding the evolution and resilience of the (built) environment (Boelens and de Roo 2016; Marchand 1984; Marshall and Marshall 2007).

On the basis of the current study, however, it is argued that urban self-organization is understood and used in many diverging, intersecting, complementary, and often contradicting ways in urban and regional planning. For a concept to have genuine value as explanans, to have true scientific values, at the very least, it needs to be conveyed in a somewhat unambiguous manner in order to let audiences get an understanding of the authors’ understanding of source and target objects (Sayer 2010). Multiple interpretations used by different groups of scholars are likely to lead to the creation of so-called epistemic communities. Epistemic communities are networks of researchers that build on each other’s expertise. Over time, these epistemic communities become more distinct as they emphasize their own conceptualization of self-organization while not being aware of the developments in adjacent communities that started with the same concept but have developed in different directions.

Next of the fact that other authors are working diverse and contradictory uses of self-organization (e.g., Rauws 2016), little persistent empirical evidence has thus far been generated to prove the many claims that are made about self-organization in urban and regional social and spatial systems. The goal of this article is therefore to map and explain the confusion of tongues

¹ Department of Public Administration and Sociology, Erasmus University Rotterdam, Rotterdam, The Netherlands
² Department of Political Science, Otto-Friedrich University Bamberg, Bamberg, Germany

Corresponding Author:
Ewald de Bruijn, Department of Public Administration and Sociology, Erasmus University Rotterdam, PO Box 1738, 3000 DR, Rotterdam, The Netherlands.
Email: e.a.debruijn@essb.eur.nl
with regard to self-organization by means of both a bibliometric analysis and a content analysis in which different epistemic communities are identified. To this end, this article follows the procedure of a systematic review according to Moher et al. (2009). Systematic reviews of published scientific results are essential in gaining an overall understanding of a concept and its applications. The main research question is: how are the diverse conceptualizations and applications of self-organization in urban planning tied to epistemic communities? From this, follow four subquestions: (1) which epistemic communities can be identified? (2) How is self-organization conceptualized within those communities? (3) Which methods are used to study self-organization within those communities? (4) What outcomes are associated with self-organization within those communities? The answers to the subquestions should provide solid evidence about the linkages between conceptualizations and applications of self-organization on the one hand and specific epistemic communities on the other. This will allow us to explain the diverging uses of the concept.

A systematic review of scientific literature has, by definition, to be systematic, transparent, and reproducible. Therefore, the methodology and an overview of the sample will be reported in second section. The results will be discussed in third section and reflected upon in fourth section. The conclusions can be found in fifth section. As mentioned above, the presentation of our findings is structured according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses checklist (Moher et al. 2009). This checklist is included in Appendix A.

**Method**

**Method and Sample**

An important step for any review is to define the main criteria for selecting data sources. Because self-organization is not exclusively tied to one approach or method, both empirical and theoretical studies were included, as well as quantitative and qualitative studies. The sample was restricted to peer-reviewed journal articles that were cited more than ten times. The time span covered in each search was 1972–2015, the starting point being given by the earliest online records. Journal articles were collected from Web of Knowledge, Scopus, and Google Scholar. The data selection was limited to studies published in English since that is the lingua franca for reporting scientific results to a broad academic audience.

Citations are regarded as a proxy for the quality of the study, which is why we selected articles that were cited more than ten times. This approach somewhat favors older publications over recent ones but that is inevitable when looking at impact: very recent papers have simply not been able to reach a wider audience. However, the sample shows no inclination in frequency toward older articles. The sample excludes books on self-organization (e.g., Allen 1997; Portugali 2012), but this is inevitable since many books are not available digitally or in libraries and therefore difficult to trace and code (see Coding section for the technique used). Last but not least, an argument can be made that books are rarely peer reviewed and have been under less scrutiny than journal articles, which is an additional motive for our selection.

**Search Queries and Sample Size**

For Web of Knowledge, the following search query was used: (“self-org*” OR “self org*”) AND (“*urban” OR “*city” OR “town” OR “metrop*” OR “municipal*”). By using wildcards (*), differences in spelling have been accounted for. This query resulted in 6,656 entries. After limiting the domain to social sciences only (excluding “science & technology” and “arts & humanities”) and to publications in English, this number was reduced to 480. To further reduce this amount of publications, several research areas that did not fall within the scope of our research were excluded, such as life sciences, neurosciences,
and zoology. This left us with 243 publications, 91 of which were cited ten times or more.

For Scopus, the same search query was used as with Web of Knowledge. The search was limited to articles within the social sciences subject area, as defined by Scopus. This netted 368 articles, of which 100 had more than ten citations.

Since Google Scholar does not allow the use of the asterisk, the query was altered slightly to accommodate for this. The first ninety entries that had more than ten citations were included in the sample. This way the total amount of article extracted from Scholar matches the results from Web of Knowledge. Since Google Scholar ranks results based on a relevance algorithm, consisting of various parameters, it favors mainstream ideas rather than fringe ideas or opposing views. Hence, the amount of articles from Google Scholar was chosen to be relatively equal to the other data sources.

### Sorting of Sample

The search above resulted in 281 titles, of which 53 concerned duplicates. Of these remaining 228 articles, 54 were excluded based on relevance, language, and not being peer-reviewed or being inaccessible. Seven items in the sample concerned books or book chapters and were excluded on the basis of the arguments mentioned in Method and Sample section. This resulted 167 articles that were fully read by both authors.

The sample was iteratively tidied up on the basis of the following considerations. The first consideration was whether an article was about urban planning and mentioned self-organization in text. Some articles would mention urban planning (as such appearing in the search) but didn’t really address it. Twenty-seven such articles were taken out of the sample. Additionally, Google Scholar sometimes included publications where the term self-organization only appeared in the reference but not in the main text. These were also left out (twenty-eight articles total).

Eight more articles were removed because they were not peer reviewed or had less than ten citations in Scopus. This “contamination” was a result of including articles from Google Scholar. Cross-checking with Scopus revealed the low number of citations. Some articles could not be cross-checked but received the benefit of the doubt and were left in the sample. The final sample then consists of 103 credible publications. The final list of publications can be found in Appendix B.

### Coding

Texts in the sample were coded using ATLAS.ti. The codes used were grouped in various code families as follows: (1) type of study, (2) conceptualization of self-organization, (3) the issue(s) or topic(s) the concept of self-organization is applied to, (4) the method(s) deployed to research self-organization, (5) and the results of the process of self-organization. Each family consists of various subcategories. Code families (1), (2), and (4) feature a limited set of subcategories predefined before the first coding cycle. Code families (3) and (5) were open.

The initial coding cycle covered the full sample, but each author coded a batch in order to distribute the workload. This first cycle resulted in 501 active codes. Subsequently, the entire codebook was cross-checked, that is, each code in each family was reassessed against the original text by the coder who had not formulated and assigned this code originally, in order to ensure a degree of intercoder reliability. This measure was also instituted to prevent confirmation bias. Subsequently, fifty-seven codes were removed from the codebook, forty-four codes were merged, and twenty-four new codes were introduced. Codes were removed if they were considered too unspecified, too vague, tautological, or when attached to a text that was going to be removed from the sample. Codes were merged if both coders had used (slightly) different codes to denote the same thing. New codes were introduced mainly as a result of a more precise rephrasing of other codes. Consequently, and together with texts that were removed after reconsideration, the codebook was reduced to 411 active codes. The second round of code merging reduced the amount of result codes to 314 unique codes. The final version of the codebook can be found in Appendix D.

### Results: A First Glance

This section will start with some general metrics of the sample. Figure 2 shows the distribution of the publications by time. When compared to Figure 1, the sample shows correspondence to the overall output. The sample skewers somewhat toward older publications because of the requirement of >10 citations, but this bias is limited because recent publications within the sample are usually cited more frequently than older ones.

The publications were divided into the two principal and discrete categories: “empirical” and “theoretical” studies. Empirical studies include modeling and both quantitative and qualitative approaches toward collecting and analyzing empirical data. Theoretical studies in this article are defined as those studies for which no primary empirical data have been collected (Ragin and Amoroso 2010). Examples of theoretical studies include theorizing or reviews without an explanation of how the data underlying the review were collected. Articles that used interviews for a quantitative purpose (i.e., Andersson and Ostrom 2008) were coded as quantitative. Articles that present overviews of modeling approaches without original work were considered theoretical. The distribution (sixty-nine empirical and thirty-four theoretical) shows that empirical studies about self-organization are prevalent. Of those empirical articles, thirty-two were based on modeling (e.g., White and Engelen 1993), while eleven studies deployed other quantitative methods such as regression analysis (e.g., Kühnert, Helbing, and West 2006). Twelve articles were based on qualitative approaches (e.g., Walker 2006), of which five articles lacked specific information about the used methods (e.g., Olsson, Folke, and Berkes 2004).

Reading, sorting, and coding of the articles led to the tentative identification of two main epistemic communities: one around modeling approaches to urban and regional spatial patterns (C1) and one around case-based approaches of
understanding self-organization through human agency (C2). To increase the robustness of this first impression and to answer subquestion 1, document characteristics such as authors and title alongside the references of articles in our sample were obtained from Scopus alongside eight manually added texts that were not present in the Scopus database. All references were cleaned to accommodate for any erroneous references or misspellings. Two approaches were used to clean up the references. First, an algorithm, on the basis of the Levenshtein coefficient was used. This checks if two strings of words are similar. Second, a manual check was performed after this step to fix any remaining errors.

Based on the references per article, two bibliographical analyses were conducted: bibliographical coupling and co-citation. Bibliographical coupling is a measure used to determine similarity between documents by comparing the degree to which they refer to similar other documents. Co-citation is a measure for similarity between references and is determined by checking whether two references occur in one document. The results for bibliographical coupling and co-citation can be found in Figures 3 and 4, respectively, in which both measures are visualized using Gephi. For purposes of readability, all documents or references have been numbered. The associated documents or references can be found in Appendices B and C.

Figure 3 shows the similarity between articles in our sample by comparing the references within these articles. The width of the arrows expresses the similarity between two texts. The place of each node in the graph is determined by similarity, resulting in a clustering of similar texts. Five articles are absent from this image because they showed no overlap at all. A visual inspection shows that the two separate communities can be identified: a tightly knit community at the bottom of the graph (C1) and a more loosely tied community at the top (C2). Furthermore, it shows that some articles fall somewhat within two branches or fall mostly outside the communities. To the left of C1 is a smaller set of articles that use a specific method (self-organizing maps [SOM]). However, this is no distinctive community, as other articles that make use of the same method fall within C1. Given the degree of overall overlap, it is clear that the communities are largely closed and that few authors use material from both communities.

In total, the sample of 103 publications contained references to 4,117 different documents. Figure 4 shows the similarity between references in our sample, that is, co-citation, for citations that co-occurred in at least three articles. When the occurrence count is lowered to two, the segregation between the communities is somewhat lowered, but other less relevant groups of co-occurring citations appear because some articles in the sample were written by the same author and share citations. The size of the circle represents the frequency of appearance. Two separate groups of references are marked in Figure 4. Group A is by far the largest batch of references in the figure and contains a host of articles from the complexity sciences and/or modeling approaches such as agent-based modeling. Also included in group A are modeling papers on economic geography. Group B involves articles relevant to theories on social capital or social ties and institution building (e.g., Ostrom 2015; Putnam 1995). The origin of references in group B is articles in C2, whereas group A are typical of C1. Coupling the information from both graphs leads to two important insights.

First, the co-citation measure reaffirms what the bibliographical coupling showed, namely, that there are two distinct communities, such as group A and group B, that match the clusters recognized in Figure 3. Secondly, the sheer difference in size between group A and group B in Figure 4 shows that C1 is more internally consistent. That is, articles in our sample that fall within C1 often refer to the same sources, whereas the same statement cannot be made for articles from C2.
Results: In-depth

Conceptualization. The discussion in the following section is structured around the remaining subquestions. The second subquestion is: how is self-organization conceptualized? It turned out to be very difficult to give one unambiguous answer to this question because more than just a few authors don’t conceptualize self-organization explicitly. Oftentimes, self-organization was used implicitly to denote self-governance or as a property of complex systems. In total, we found five discrete conceptualizations (see Table 1). Some articles contain multiple of these conceptualizations, which is why the total does not add up to 103.

Self-organization under conceptualization #1 here is often based on a long history, starting at Ashby in 1947 (de Wolf and Holvoet 2004) and also popularized in thermodynamics (Prigogine and Stengers 1984). Put concisely, self-organization is the property of complex systems that is the resultant of internal changes and external influences. There is no central control that mandates the emerging macrostructure. In return, the macro-level influences the microlevel. Self-organization in the
glossary of complex systems has some leeway in terms of meaning and application. A discussion and elaboration on this is too extensive for the purposes of this article and can be found elsewhere (e.g., de Wolf and Holvoet 2004).

Conceptualization #2 deals with the emergence of macro patterns through local interactions in a very concrete fashion. It is applied in various ways, ranging from the emergence of interaction structures between governments, the emergence of transport networks, to the movements of individuals (cf. Helbing et al. 2005; Shresta and Feiock 2009; Xie and Levison 2009). The major differentiator between conceptualizations #1 and #2 is that #1 refers to the nomenclature of complexity theory (e.g., emergence, nonlinearity, dissipative structures, entropy, order, and chaos), while #2 refers to the type of mechanism identified by Schelling (2006).

Conceptualization #3 sees self-organization as self-governance. It refers to autonomy, independence from the state of a group of individuals, or cooperation between (groups of) individuals in the context of civil society. The central concept was not always defined precisely so self-organization has a rather broad meaning here, generally referring to people engaging in activities without being ordered to do so. Furthermore, self-organization isn’t always positioned as the main concept of the article but for example as part of a definition for what constitutes urban (self-) governance (Davies 2005).

Conceptualization #4 refers to power laws and self-organized critically. Here, self-organization means that systems maintain themselves at a critical threshold (Bak 1990; Batty 1998). The typical example of self-organized criticality is a pile of sand on which particles of sand are dropped. When the slope of the pile of sand becomes too steep, it pushes the system too far from equilibrium, and an avalanche occurs from which a new (barely) stable system state emerges. In such a system, smaller avalanches occur more frequently than large avalanches (Bak, Tang, and Wiesenfeld 1988).

Conceptualization #5 is tied to the use of a specific form of neural network models that learn without superimposed instructions, called SOM. In articles using SOM (e.g., Bloom 2005), an explicit conceptualization is often missing because the concept is the method here.

Overall, conceptualization #3 differs the most from other conceptualizations as it relates to governance and civil society, whereas the other conceptualizations involve structure and (distributive) dynamics of (complex) systems without being very explicit about the relationship between state and society. The conceptualizations need not necessarily to be exclusive. For example, the emergence of cooperation between individuals (conceptualization #3) is also a matter of emerging structure (conceptualization #2). Within the different communities depicted in Figures 3 and 4, conceptualization #3 is tightly linked to C2.

The overall picture shows that the conceptualizations are broad and sometimes ambiguous. A likely cause for this is that the more precise a conceptualization is, the less likely it will be to be used again by others because of the specific situations it is applied to. Conversely, generic conceptualizations fit easily with many types of research but are not very informative.

Methods. The third subquestion concerns the question the methods used to study self-organization. Within the sample, we can see a clear preference for emergence-type modeling approaches such as agent-based modeling and cellular automata. Naturally, this is the exclusive domain of C1. One of the
strengths of modeling is that it forces the researcher to be very precise about the conceptualization and properties of self-organization (Klein 2015). It is therefore no surprise that explicit conceptualizations and operationalization are usually found in modeling attempts.

The qualitative studies prevalent in C2 seem to favor case-based approaches to researching self-organization. The techniques deployed vary between interviews, field observations, and writing down personal experiences obtained in projects. Generally speaking, qualitative methods can be geared toward understanding certain causal relationships rather than mapping those relationships. As such, it is no surprise that conceptualizations are more intimately tied to the ways in which an author understands the phenomenon, an understanding that can be hard to communicate to a wider audience.

Naturally, the discussion about methods doesn’t concern the theoretical studies. There are frameworks available to structure literature reviews—such as the one deployed in this article—thereby turning theoretical endeavors into methodologically transparent, structured empirical data analyses. However, none of the theoretical articles in the sample provided any clarity on the selection of sources and ideas.

**Results of self-organization.** The final subquestion is “What outcomes are associated with self-organization within those communities?” After a first round of merging codes, 118 different results from self-organization were identified, varying from concrete results such as grassroots groups and industrial clusters to abstract measures such as weak-tie relationships. More than half of these results only occurred once in our sample. Hence, the results will be discussed on a more aggregated level. The 118 codes were reduced to twenty-two aggregated results. These in turn were fit into broader categories of results regarding distribution, social processes, information, economic output, and institutional context.

Distributive results from self-organization refer to results from self-organizing processes that move objects over space. This can involve the distribution of economic entities over a land mass or within cities, the distribution of demographics within cities or countries, the distribution of traffic flows in areas, or the distribution of built space within city contexts (e.g., Allen and Sanglier 1981; Batten 2001; Dymski 1996; Yerra and Levinson 2005). In most cases, distributive results can be found within articles from C1, as modeling approaches are typically distributive in nature and ask how certain structures emerge as a result of push- or pull-factors. Very often, this involves a form of homophily, such as the notion that similar people will live in similar areas or that an economic benefit can be obtained by having similar companies next to each other.

Results regarding social processes occur in cases where self-organizing processes lead to cohesion, robust networks capable of dealing with change, or reciprocal relations among humans. Alternatively, some studies into self-organization investigate how certain (types of) networks emerge (e.g., Feiock et al. 2010). The results are then discussed in terms of types of network structures. These structural properties of networks were also placed within the category of results regarding social processes.

Information results are those results that deal with the following three subcategories: (1) reframing, producing, and sharing ideas or information (Feiock et al. 2010; Portugali 1997, 2006); (2) innovating upon existing ideas or information (e.g., Olsson, Folke, and Berkes 2004); or (3) reaching (dis)agreement on information or ideas (e.g., Lemanski 2008). This category was set up broadly to incorporate results in the area of innovation (subcategory 2) as well as results regarding reached consensus within policy processes (subcategory 3).

Economic output refers to results in terms of increased profit margins, reduced transaction costs, or robust economic networks. These most often return in modeling studies, although reduced transaction costs also return in studies into governance networks (e.g., Shrestha and Feiock 2009, 2011).

Institutional results are results that deal with settings in which decision-making or collaboration occurs. Two somewhat opposing results can be found here. One strand of literature that deals with institutional results investigates how self-organization leads to collaborative capacity, whereas another series of articles detail how power structures emerge. The second result may hamper collaboration, empowered actors enforce their own agenda at the expense of other stakeholders (e.g., Boonstra and Boelens 2011; Lemanski 2008).

Besides collaborations among public entities are collaborations in which citizens are coproducing services together with or alongside governments. To distinguish between them, the second type of collaboration is dubbed “civic participation.” The emergence of rules and their enforcement is a final result that may occur due to self-organization. Self-organization that has institutional results is often conceptualized as self-governance.

Although the above discussion of the results is largely concise, we don’t intend to disguise the large range of results underlying these categories. In itself, a large variety of results is not an issue. However, the large amount of results that can be present in one research highlights the issue of causality. Most studies acknowledge that various factors appear in combination with others—there were very few instances where monicausality was suggested—and that these combined lead to certain outcomes. Overall, little attention was paid to such equifinality, however. Equifinality refers to the notion that there is more than one way to achieve a certain result. If there are more than one ways to achieve a specific result, then some caution regarding the results of these studies is warranted. For example, the fact that self-organizing processes may lead to collaboration or to power balances that hamper self-organization points to similar processes that may lead to conflicting or contradictory results.

Furthermore, by their very nature, the modeling studies prevalent in C1 predefine a set of factors from which the self-organizing pattern will emerge, so that inevitably will lead to the conclusion that such factors lead to self-organization—it is in the design of the method to see it that way. The method narrows down the scope of outcomes of self-organization to
Spatial patterns. Core factors are often derived from other, earlier sources, leading to considerable repetition of the same factors within the modeling community.

Explaining Differences

If anything, the findings reported in the previous sections show that there is considerable diversity in the ways in which self-organization is understood and utilized and the conclusions that are drawn from it. Indeed, it is practically impossible to list all the types of outcomes here without aggregating them into categories. This is even more of a problem when it comes to listing all the causal chains that researchers have looked at: a bewildering amount of factors have been reported. This is considerably more prevalent in C2 than it is in C1. At the other end of the scale, we find research that is completely lacking in this area. Again, this happens more in C2 than in C1, presumably because modeling simply forces the researcher to become clear about the factors considered in the model.

At first glance, the current state of the topic seems to suggest that there is very little knowledge accumulation when it comes to self-organization in urban and regional planning studies. There is little cross-fertilization across the communities; the few sources used in both communities often concern cursory references. This could be a sobering observation.

The first impression, however, requires a more in-depth understanding of the findings. First of all, one could argue that some knowledge accumulation may still be present within the two communities. The strong internal coherence—as expressed in the reference patterns—could be an indicator for that. The communities are relatively consistent in referring to similar sources within their epistemic community—C1 more than C2. The internal consistency is mostly achieved through the self-referential nature of the communities, again demonstrated by the reference patterns. Authors keep referring to the more common sources within that particular community, which reinforces the belief of yet other authors that those sources are the most important ones and therefore need to be referred to. The same holds true for conceptualization and factors: they are often echoed from previous sources within the community but not across the communities.

Secondly, it could be argued that the diverging uses of the concept simply prohibit overall knowledge accumulation because researchers are using it in different ways for looking at different research objects. This is where the issue of theory transfer comes to the fore (e.g., Mäki 2009). In the most basic sense of the word, self-organization can be seen as a term devoid of any specific application. In other words, it can’t be understood as an abstract direct representation (Weisberg 2007) of all the social phenomena researched in the articles included in this study. Indeed, no concept can represent the real world accurately (Knautt 2011). The transfer then encompasses the modification that takes place between the source domain and target domain. Often, the differences between the two are so extensive that this modification is necessary. Consider, for example, Portugali’s discussion of the balconies of Tel Aviv and how the same reference has been used in research about self-organizing capacity in governance arrangements. It is only natural that the differences in the target domain necessitate a modification of the concept and its use in the source domain. This modification can take place on either one or both of the following two levels: the syntactic structure and the semantic dimension. The properties of the target domain could, for example, allow for a transfer of the syntactic structure but not tolerate the transfer of the semantics. Or, conversely, would allow the semantics to stay the same while requiring a change of the syntactic structure (Weisberg 2007). Both instances have been observed. For example, some authors used self-organization as a verb that represents activities of local citizens, while others used it as a core mechanisms of their method (a mechanism encapsulated in algorithms), and yet others used it to refer to properties of complex systems.

There is always a danger that in a strict transformation and application of the model, the idealized model cannot accommodate certain features of the target domain, while in a rather free application, any two things can be considered as arbitrarily similar (Bolinska 2013, 220). In order to properly transfer and apply a concept to a new target domain, it should achieve articulated awareness of the nature of the objects and relations in that target domain (Woody 2004). As such, it is reasonable to expect that there are diverging uses and applications of the concept, over time resulting in distinct communities. Naturally, it is important that the authors map the meaning of the concept in both the source and the target domain and the changes occurring during the transfer (Bolinska 2013). This often doesn’t happen. On the surface, the use of the term seems coherent because it concerns related phenomena, but authors may point to entirely different concepts, within different research traditions and histories of the use of certain variables and causal mechanisms because of the theory transfer that took place.

Conclusion and Discussion

We have identified and mapped two distinct and relatively self-referential communities with regard to self-organization in urban and regional planning research. The communities are primarily defined by method and conceptualization, but we noted that they are also fairly consistent when it comes to the results of self-organization. Yet, we can also observe considerable variety with regard to these factors. This variety is more prevalent in C2, which can be explained by the contextual nature of the qualitative (single) case studies popular within this community. We do see some signs of authors combining insights between the two epistemic communities but not to the extent that we speak of convergence between the communities. While this issue requires ongoing attention in this burgeoning niche, it doesn’t mean that the situation is helpless. On the contrary, conceptual purity, scientific progress, and falsification in the fashion of Popper do not reflect the state and operations of the social sciences. It is part of the scientific endeavor
that we poke in different directions, try out things, and see what
sticks in the long run. Inevitably, those attempts are not always
consistent or even coherent. Scientific progress is very much
about the question which representation can accurately
describe the world (Knuuttila 2011) and attempts at answering
that question constitutes a noncumulative process where frag-
mentation is inevitable, and essential, in trying out different
answers.

Appendix A

Table A1. PRISMA Checklist.

| Section/Topic                | No. | Checklist Item                                                                 |
|------------------------------|-----|---------------------------------------------------------------------------------|
| Title                        | 1   | Identify the report as a systematic review, meta-analysis, or both.            |
| Title                        | 1   | Provide a structured summary including, as applicable, background: objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number. |
| Abstract Structured summary  | 2   | Rationale for the review in the context of what is already known.              |
| Abstract Structured summary  | 2   | Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS). |
| Introduction Rationale       | 3   | Describe the rationale for the review in the context of what is already known. |
| Introduction Rationale       | 3   | Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS). |
| Methods Protocol and         | 5   | Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number. |
| Methods Protocol and         | 5   | Specify study characteristics (e.g., PICOS and length of follow-up) and report characteristics (e.g., years considered, language, and publication status) used as criteria for eligibility, giving rationale. |
| Methods Information sources  | 7   | Describe all information sources (e.g., databases with dates of coverage and contact with study authors to identify additional studies) in the search and date last searched. |
| Methods Search               | 8   | Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated. |
| Methods Study selection      | 9   | State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis). |
| Methods Data collection      | 10  | Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators. |
| Methods Data items           | 11  | List and define all variables for which data were sought (e.g., PICOS and funding sources) and any assumptions and simplifications made. |
| Risk of bias in individual   | 12  | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. |
| Risk of bias in individual   | 12  | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. |
| Risk of bias in individual   | 12  | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. |
| Risk of bias in individual   | 12  | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. |
| Risk of bias in individual   | 12  | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. |
| Risk of bias across studies  | 15  | Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias and selective reporting within studies). |
| Additional analyses          | 16  | Describe methods of additional analyses (e.g., sensitivity or subgroup analyses and meta-regression), if done, indicating which were pre-specified. |
| Results Study selection      | 17  | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram. |
| Results Study selection      | 17  | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram. |
| Results Study characteristics| 18  | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, and follow-up period) and provide the citations. |
| Results Risk of bias within  | 19  | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). |
| Results Risk of bias within  | 19  | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). |
| Results Results of individual| 20  | For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot. |
| Results Synthesis of results | 21  | Present results of each meta-analysis done, including confidence intervals and measures of consistency. |
| Results Risk of bias across  | 22  | Present results of any assessment of risk of bias across studies (see Item 15). |

(continued)
Table A1. (continued)

| Section/Topic   | No. | Checklist Item                                                                 | Reported on Page No. |
|-----------------|-----|---------------------------------------------------------------------------------|----------------------|
| Additional analysis | 23  | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses and meta-regression [see item 16]) | N/A                  |
| Discussion      |     |                                                                                  |                      |
| Summary of evidence | 24  | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., health-care providers, users, and policy makers) | 24–27                |
| Limitations     | 25  | Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research and reporting bias) | N/A                  |
| Conclusions     | 26  | Provide a general interpretation of the results in the context of other evidence and implications for future research | 27–28                |
| Funding         |     |                                                                                  |                      |
| Funding        | 27  | Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review | 23                   |

Source: From Moher D., A. Liberati, J. Tetzlaff, D.G. Altman, and the PRISMA Group. 2009. “Preferred Reporting Items for Systematic Reviews and Meta-analyses: The PRISMA Statement.” PLoS Medicine 6 (6): e1000097. doi: 10.1371/journal.pmed1000097.

Appendix B

Table B1. List of Publications Included in the Final Sample and Legend for Figure 3.

| Number in Figure 3 | Title                                                                 |
|--------------------|----------------------------------------------------------------------|
| 1                  | Ahern, J. 2011. “From Fail-safe to Safe-to-fail: Sustainability and Resilience in the New Urban World.” Landscape and Urban Planning 100 (4): 341–43 |
| 2                  | Ahern, J. 2013. “Urban Landscape Sustainability and Resilience: The Promise and Challenges of Integrating Ecology with Urban Planning and Design.” Landscape Ecology 28 (6): 1203–212 |
| 3                  | Alberti, M., J. M. Marzluff, E. Shulenberger, G. Bradley, C. Ryan, and C. Zumbrunnen. 2003. “Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems.” Bioscience 53 (12): 1169–179 |
| 4                  | Alberti, M., and P. Waddell. 2000. “An Integrated Urban Development and Ecological Simulation Model.” Integrated Assessment 1 (3): 215–27 |
| 5                  | Alfasi, N., and J. Portugali. 2004. “Planning Just-in-time versus Planning Just-in-case.” Cities 21 (1): 29–39. doi: 10.1016/j.cities.2003.10.007 |
| 6                  | Alfasi, N., and J. Portugali. 2007. “Planning Rules for a Self-planned City.” Planning Theory 6 (2): 164–82. doi: 10.1177/1473095207077587 |
| 7                  | Aligica, P. D., and V. Tarko. 2012. “Polycentricity: From Polanyi to Ostrom, and Beyond.” Governance—An International Journal of Policy Administration and Institutions 25 (2): 237–62. doi: 10.1111/j.1468-0491.2011.01550.x |
| 8                  | Allen, P. M., and M. Sangler. 1981. “Urban Evolution, Self-organization, and Decision-making.” Environment and Planning A 13 (2): 167–83. doi: 10.1068/a130167 |
| 9                  | Andersson, K. P., and E. Ostrom. 2008. “Analyzing Decentralized Resource Regimes From a Polycentric Perspective.” Policy Sciences 41 (1): 71–93. doi: 10.1007/s11777-007-9055-6 |
| 10                 | Arribas-Bel, D., P. Nijkamp, and H. Scholten. 2011. “Multidimensional Urban Sprawl in Europe: A Self-organizing Map Approach.” Computers Environment and Urban Systems 35 (4): 263–75. doi: 10.1016/j.compenvurbsys.2010.10.002 |
| 11                 | Baiocchi, G., P. Heller, and M. K. Silva. 2008. “Making Space for Civil Society: Institutional Reforms and Local Democracy in Brazil.” Social Forces 86 (3): 911–36. |
| 12                 | Batten, D. F. 2001. “Complex Landscapes of Spatial Interaction.” Annals of Regional Science 35 (1): 81–111. doi: 10.1007/s001680000032 |
| 13                 | Batty, M. 1998. “Urban Evolution on the Desktop: Simulation with the Use of Extended Cellular Automata.” Environment and Planning A 30 (11): 1943–967. doi: 10.1068/a301943 |
| 14                 | Benenson, I. 1999. “Modeling Population Dynamics in the City: From a Regional to a Multi-agent Approach.” Discrete Dynamics in Nature and Society 3 (2–3): 149–70. |
| 15                 | Benenson, I., I. Omer, and E. Hatna. 2002. “Entity-based Modeling of Urban Residential Dynamics: The Case of Yaffo, Tel Aviv.” Environment and Planning B 29 (4): 491–512. |
| 16                 | Benenson, I., and P. M. Torrens. 2004. Geosimulation: Automata-based Modeling of Urban Phenomena. John Wiley. |
| 17                 | Benenson, I., S. Aronovich, and S. Noam. 2005. “Let’s Talk Objects: Generic Methodology for Urban High-resolution Simulation.” Computers, Environment and Urban Systems 29 (4): 425–53. doi: 10.1016/j.compenvurbsys.2003.11.008 |

(continued)
Table B1. (continued)

| Number in Figure 3 | Title |
|---------------------|-------|
| 46                  | Kalikoski, D. C., P. Quevedo Neto, and T. Almudi. 2010. “Building Adaptive Capacity to Climate Variability: The Case of Artisanal Fisheries in the Estuary of the Patos Lagoon, Brazil.” Marine Policy 34 (4): 742–51. doi: 10.1016/j.marpol.2010.02.003 |
| 47                  | Kipfer, S. 2002. “Urbanization, Everyday Life and the Survival of Capitalism: Lefebvre, Gramsci and the Problematic of Hegemony.” Capitalism, Nature, Socialism 13 (2): 117–49 |
| 48                  | Kourtis, K., P. Nijkamp, and D. Arribas. 2012. “Smart Cities in Perspective—A Comparative European Study by Means of Self-organizing Maps.” Innovation: The European Journal of Social Science Research 25 (2): 229–46 |
| 49                  | Kropp, J. 1998. “A Neural Network Approach to the Analysis of City Systems.” Applied Geography 18 (1): 83–96. doi: 10.1016/S0143-6228(97)00048-9 |
| 50                  | Krugman, P. 1995. “Innovation and Agglomeration: Two Parables Suggested by City-size Distributions.” Japan and the World Economy 7 (4): 371–90 |
| 51                  | Krugman, P. 1999. “The Role of Geography in Development.” International Regional Science Review 22 (2): 142–61. doi: 10.1177/016001799761012307 |
| 52                  | Kühnert, C., D. Helbing, and G. B. West. 2006. “Scaling Laws in Urban Supply Networks.” Physica A: Statistical Mechanics and Its Applications 363 (1): 96–103 |
| 53                  | Lange, B., A. Kalandides, B. Stoeber, and H. A. Mieg. 2008. “Berlin’s Creative Industries: Governing Creativity!” Industry and Innovation 15 (5): 531–48. doi: 10.1080/14606920802373981 |
| 54                  | Leitner, H., and E. Sheppard. 2002. “The City Is Dead, Long Live the Net”: Harnessing European Interurban Networks for a Neoliberal Agenda.” Antipode 34 (3): 495–518. doi: 10.1111/1467-8330.00252 |
| N/A                 | Lemanski, C. 2008. “Houses without Community: Problems of Community (In)capacity in Cape Town, South Africa.” Environment and Urbanization 20 (2): 393–410. doi: 10.1177/095624708096119 |
| 55                  | Lin, Y., B. de Meulder, and S. Wang. 2011. “Understanding the ‘Village in the City’ in Guangzhou: Economic Integration and Development Issue and Their Implications for the Urban Migrant.” Urban Studies 48 (16): 583–598. doi: 10.1177/0042098010396239 |
| 56                  | Liu, Y., S. He, F. Wu, and C. Webster. 2010. “Urban Villages under China’s Rapid Urbanization: Unregulated Assets and Transitional Neighbourhoods.” Habitat International 34 (2): 135–44. doi: 10.1016/j.habitatint.2009.08.003 |
| 57                  | Long, Y., Q. Mao, and A. Dang. 2009. “Beijing Urban Development Model: Urban Growth Analysis and Simulation.” Tsinghua Science & Technology 14 (6): 782–94 |
| 58                  | Mahon, R., P. McConney, and R. N. Roy. 2008. “Governing Fisheries as Complex Adaptive Systems.” Marine Policy 32 (1): 104–12. doi: 10.1016/j.marpol.2007.04.011 |
| 59                  | Mehaffy, M., S. Porta, Y. Rofe, and N. Salingaros. 2010. “Urban Nuclei and the Geometry of Streets: The ‘Emergent Organizing City’.” Urban Design International 15 (1): 22–46. doi: 10.1057/udi.2009.26 |
| 60                  | Nijkamp, P. 2008. “XXQ Factors for Sustainable Urban Development: A Systems Economics View.” Rumanian Journal of Regional Science 2 (1): 1–34 |
| 61                  | O’Sullivan, D. 2004. “Complexity Science and Human Geography.” Transactions of the Institute of British Geographers 29 (3): 282–95. doi: 10.1111/j.0261-0121.2004.00321.x |
| 62                  | Olsson, P., C. Folke, and F. Berkes. 2004. “Adaptive Comanagement for Building Resilience in Social-ecological Systems.” Environmental Management 34 (1): 75–90. doi: 10.1007/s00267-003-0101-7 |
| 63                  | Portugali, J., I. Benenson, and I. Omer. 1994. “Sociospatial Residential Dynamics—Stability and Instability within A Self-organizing City.” Geographical Analysis 26 (4): 321–40 |
| 64                  | Portugali, J., and I. Benenson. 1995. “Artificial Planning Experience by Means of a Heuristic Cell-space Model—Simulating International Migration in the Urban Process.” Environment and Planning A 27 (10): 1647–665. doi: 10.1068/a271647 |
| 65                  | Portugali, J. 1997. “Self-organizing Cities.” Futures 29 (4–5): 353–80. doi: 10.1016/S0016-3287(97)00022-0 |
| 66                  | Portugali, J. 2006. “Complexity Theory as a Link between Space and Place.” Environment and Planning A 38 (4): 647–64. doi: 10.1068/a37260 |
| 67                  | Portugali, J. 2008. “Learning from Paradoxes about Prediction and Planning in Self-organizing Cities.” Planning Theory 7 (3): 248–62. doi: 10.1080/1473095208094823 |
| 68                  | Read, B. L. 2003. “Democratizing the Neighbourhood? New Private Housing and Home-owner Self-organization in Urban China.” China Journal 49: 31–59 |
| 69                  | Read, B. L. 2008. “Assessing Variation in Civil Society Organizations: China’s Homeowner Associations in Comparative Perspective.” Comparative Political Studies 41 (9): 1240–265. doi: 10.1177/0010414007302340 |
| N/A                 | Roy, A. 2011. “Slumdog Cities: Rethinking Subaltern Urbanism.” International Journal of Urban and Regional Research 35 (2): 223–38. doi: 10.1111/j.1468-2427.2011.01051.x |
| 70                  | Ruth, M., and D. Coelho. 2007. “Understanding and Managing the Complexity of Urban Systems under Climate Change.” Climate Policy 7 (4): 317–36 |
| 71                  | Schweitzer, F., and J. Steinbrink. 1998. “Estimation of Megacity Growth—Simple Rules versus Complex Phenomena.” Applied Geography 18 (1): 69–81. doi: 10.1016/S0143-6228(97)00047-7 |
| N/A                 | Seet, B., G. Liu, B. Lee, C. Foh, K. Wong, and K. Lee. 2004. “A-STAR: A Mobile Ad Hoc Routing Strategy for Metropolis Vehicular Communications.” Networking 2004, 989–99 |

(continued)
| Number in Figure 3 | Title |
|------------------|-------|
| 72 | Shrestha, M. K., and R. C. Feiock. 2011. “Transaction Cost, Exchange Embeddedness, and Interlocal Cooperation in Local Public Goods Supply.” *Political Research Quarterly* 64 (3): 573–87. doi: 10.1177/1065912910370683 |
| 73 | Shrestha, M. K., and R. C. Feiock. 2009. “Governing US Metropolitan Areas Self-organizing and Multiplex Service Networks.” *American Politics Research* 37 (5): 801–23. doi: 10.1177/1532753X09337466 |
| 74 | Silva, E. A., and K. Clarke. 2005. “Complexity, Emergence and Cellular Urban Models: Lessons Learned from Applying SLEUTH to Two Portuguese Metropolitan Areas.” *European Planning Studies* 13 (1): 93–115 |
| 75 | Spielman, S. E., and J. Thill. 2008. “Social Area Analysis, Data Mining, and GIS.” *Computers, Environment and Urban Systems* 32 (2): 110–22. doi: 10.1016/j.compenvurbsys.2007.11.004 |
| 76 | Sui, D. Z., and H. Zeng. 2001. “Modeling the Dynamics of Landscape Structure in Asia’s Emerging Desakota Regions: A Case Study in Shenzhen.” *Landscape and Urban Planning* 53 (1): 37–52 |
| 77 | Surazska, W., J. Bucek, L. Malikova, and P. Danek. 1997. “Towards Regional Government in Central Europe: Territorial Restructuring of Postcommunist Regimes.” *Environment and Planning C: Government and Policy* 15 (4): 437–62 |
| 78 | Syphard, A. D., K. Clarke, and J. Franklin. 2005. “Using a Cellular Automaton Model to Forecast the Effects of Urban Growth on Habitat Pattern in Southern California.” *Ecological Complexity* 2 (2): 185–203 |
| 79 | Teisman, G. R., and J. Edelenbos. 2011. “Towards a Perspective of System Synchronization in Water Governance: A Synthesis of Empirical Lessons and Complexity Theories.” *International Review of Administrative Sciences* 77 (1): 101–18. doi: 10.1177/0020852310390121 |
| 80 | Teodorovic, D. 2003. “Transport Modeling by Multi-agent Systems: A Swarm Intelligence Approach.” *Transportation Planning and Technology* 26 (4): 289–312. doi: 10.1080/0308106032000154593 |
| 81 | Teodorovic, D. 2008. “Swarm Intelligence Systems for Transportation Engineering: Principles and Applications.” *Transportation Research Part C: Emerging Technologies* 16 (6): 651–67. doi: 10.1016/j.trc.2008.03.002 |
| 82 | Tidball, K. G., M. E. Krasny, E. Svendsen, L. Campbell, and K. Helphand. 2010. “Stewardship, Learning, and Memory in Disaster Resilience.” *Environmental Education Research* 16 (5–6): 591–609. doi: 10.1080/13504622.2010.505437 |
| 83 | Tremblay, D., and T. Pilati. 2007. “Tehu and Artist-run Centres in Montreal: Contributions to the Creative City.” *Canadian Journal of Regional Science* 30 (2): 337–58 |
| 84 | Teodorovic, D. 2006a. “Interweaving Aboriginal/Indigenous Rights with Urban Citizenship: A View from the Winnipeg Low-cost Housing Sector, Canada.” *Citizenship Studies* 10 (4): 391–411. doi: 10.1080/13698210600855096 |
| 85 | Walker, R. C. 2006b. “Searching for Aboriginal/Indigenous Self-determination: Urban Citizenship in the Winnipeg Low-cost Housing Sector, Canada.” *Environment and Planning A* 38 (12): 2345–363. doi: 10.1068/a38136 |
| 86 | Teodorovic, D. 2006b. “Searching for Aboriginal/Indigenous Self-determination: Urban Citizenship in the Winnipeg Low-cost Housing Sector, Canada.” *Environment and Planning A* 38 (12): 2345–363. doi: 10.1068/a38136 |
| 87 | Ward, D. P., A. T. Murray, and S. R. Phinn. 2000. “A Stochastically Constrained Cellular Model of Urban Growth.” *Computers, Environment and Urban Systems* 24 (6): 539–58. doi: 10.1016/S0198-9715(00)00008-9 |
| 88 | Webster, C., and F. L. Wu. 2001. “Coase, Spatial Pricing and Self-organising Cities.” *Urban Studies* 38 (11): 2037–54. doi: 10.1080/00420980120080925 |
| 89 | White, R., and G. Engelen. 1993. “Cellular Automata and Fractal Urban Form: A Cellular Modelling Approach to the Evolution of Urban Land-use Patterns.” *Environment and Planning A* 25 (8): 1175–199 |
| 90 | White, R., and G. Engelen. 1994. “Urban Systems Dynamics and Cellular Automata: Fractal Structures between Order and Chaos.” *Chaos, Solitons & Fractals* 4 (4): 563–83 |
| 91 | Wu, F. 1996. “A Linguistic Cellular Automata Simulation Approach for Sustainable Land Development in a Fast Growing Region.” *Computers, Environment and Urban Systems* 20 (6): 367–87. doi: 10.1016/S0198-9715(97)90003-3 |
| 92 | Wu, F., and D. Martin. 2002. “Urban Expansion Simulation of Southeast England Using Population Surface Modelling and Cellular Automata.” *Environment and Planning A* 34 (10): 1855–876. doi: 10.1068/a3520 |
| 93 | Wu, F., and C. J. Webster. 2000. “Simulating Artificial Cities in a GIS Environment: Urban Growth under Alternative Regulation Regimes.” *International Journal of Geographical Information Science* 14 (7): 625–48 |
| 94 | Walti, S., and D. Kubler. 2003. “‘New Governance’ and Associative Pluralism: The Case of Drug Policy in Swiss Cities.” *Policy Studies Journal* 31 (4): 499–525. doi: 10.1111/1541-0072.00040 |
| 95 | Xie, F., and D. Levinson. 2009. “Topological Evolution of Surface Transportation Networks.” *Computers, Environment and Urban Systems* 33 (3): 211–23. doi: 10.1016/j.compenvurbsys.2008.09.009 |
| 96 | Yao, X. 2007. “Where are Public Transit Needed—Examining Potential Demand for Public Transit for Commuting Trips.” *Computers, Environment and Urban Systems* 31 (5): 535–50 |
| 97 | Yerra, B. M., and D. M. Levinson. 2005. “The Emergence of Hierarchy in Transportation Networks.” *The Annals of Regional Science* 39 (3): 541–53 |
| 98 | Yzhaq, H., B. A. Portnov, and E. Meron. 2004. “A Mathematical Model of Segregation Patterns in Residential Neighbourhoods.” *Environment and Planning A* 36 (1): 149–72 |
| 99 | Young, I. M. 1999. “Residential Segregation and Differentiated Citizenship.” *Citizenship Studies* 3 (2): 237–52 |
| 100 | Yuan, F. 2010. “Urban Growth Monitoring and Projection Using Remote Sensing and Geographic Information Systems: A Case Study in the Twin Cities Metropolitan Area, Minnesota.” *Geocarto International* 25 (3): 213–30 |
| 101 | Zhang, L., T. M. Garoni, and J. de Gier. 2013. “A Comparative Study of Macroscopic Fundamental Diagrams of Arterial Road Networks Governed by Adaptive Traffic Signal Systems.” *Transportation Research Part B: Methodological* 49: 1–23
### Appendix C

#### Table C1. Legend for Figure 4.

| Number in Figure 4 | Title |
|--------------------|-------|
| 1                  | Holling, C. S. 1978. *Adaptive Environmental Assessment and Management*. John Wiley |
| 2                  | Alonso, W. 1964. *Location and Land Use. Toward a General Theory of Land Rent. Location and Land Use. Toward a General Theory of Land Rent* |
| 3                  | Batty, M. 1997. “Cellular Automata and Urban Form: A Primer.” *Journal of the American Planning Association* 63 (2): 266–74 |
| 4                  | Batty, M., and Y. Xie. 1994. “From Cells to Cities.” *Environment and Planning B: Planning and Design* 21 (7): S31–S48 |
| 5                  | Clarke, K. C., S. Hoppen, and L. Gaydos. 1997. “A Self-modifying Cellular Automaton Model of Historical Urbanization in the San Francisco Bay Area.” *Environment and Planning B: Planning and Design* 24 (2): 247–61 |
| 6                  | Couclelis, H. 1985. “Cellular Worlds: A Framework for Modeling Micro–Macro Dynamics.” *Environment and Planning A* 17 (5): 585–96 |
| 7                  | Couclelis, H. 1997. “From Cellular Automata to Urban Models: New Principles for Model Development and Implementation.” *Environment and Planning B: Planning and Design* 24 (2): 165–74 |
| 8                  | White, R., G. Engelen, and I. Uljee. 1997. “The Use of Constrained Cellular Automata for High-resolution Modelling of Urban Land-use Dynamics.” *Environment and Planning B: Planning and Design* 24 (3): 323–43 |
| 9                  | Wu, F., and C. J. Webster. 1998. “Simulation of Land Development through the Integration of Cellular Automata and Multicriteria Evaluation.” *Environment and Planning B: Planning and Design* 25 (1): 103–26 |
| 10                 | Jacobs, J. 1961. *The Death and Life of Great American Cities*. New York: Vintage |
| 11                 | Portugali, J. 2012. *Self-organization and the City*. Springer Science & Business Media |
| 12                 | Harvey, D. 1973. *Social Justice and the City*. London: Edward Arnold |
| 13                 | McGinnis, M. D. 1999. *Polycentricity and Local Public Economies: Readings from the Workshop in Political Theory and Policy Analysis*. University of Michigan Press |
| 14                 | Ostrom, E. 2015. *Governing the Commons*. Cambridge University Press |
| 15                 | Ostrom, E. 2005. *Understanding Institutional Diversity*. Princeton University Press |
| 16                 | Losch, A. 1954. *Economics of Location* |
| 17                 | Nicolis, G., and I. Prigogine. 1977. *Self-organization in Nonequilibrium Systems*, vol. 19 (1977). New York: Wiley |
| 18                 | Fujita, M., P. R. Krugman, A. J. Venables, and M. Fujita. 1999. *The Spatial Economy: Cities, Regions and International Trade*, vol. 213. Cambridge: MIT Press |
| 19                 | Kohonen, T. 2001. *Self-organizing Maps*. Springer: Berlin, Germany |
| 20                 | Allen, P. M., and M. Sanglier. 1981. “Urban Evolution, Self-organization, and Decisionmaking.” *Environment and Planning A* 13 (2): 167–83 |
| 21                 | Bak, P. 1996. *How Nature Works: The Science of Self Organized Criticality*. New York: Springer Verlag |
| 22                 | Batty, M., H. Couclelis, and M. Eichen. 1997. *Urban Systems as Cellular Automata* |
| 23                 | Epstein, J. M., and R. Axtell. 1996. *Growing Artificial Societies: Social Science from the Bottom Up*. Brookings Institution Press |
| 24                 | Holland, J. H. 2000. *Emergence: From Chaos to Order*. OUP Oxford |
| 25                 | Isard, W. 1956. *Location and Space-economy* |
| 26                 | Krugman, P. 1993. “On the Number and Location of Cities.” *European Economic Review* 37 (2–3): 293–98 |
| 27                 | Krugman, P. 1996. *The Self-organizing Economy*. Cambridge, MA: Blackwell |
| 28                 | Portugali, J., I. Benenson, and I. Omer. 1994. “Sociospatial Residential Dynamics: Stability and Instability within a Self-organizing City.” *Geographical Analysis* 26 (4): 321–40 |
| 29                 | Portugali, J., I. Benenson, and I. Omer. 1997. “Spatial Cognitive Dissonance and Sociospatial Emergence in a Self-organizing City.” *Environment and Planning B: Planning and Design* 24 (2): 263–85 |
| 30                 | Zipf, G. 1949. *Human Behaviour and the Principle of Least Effort Addaon*. Wesley |
| 31                 | Bak, P., and K. Chen. 1991. “Self-organized Criticality.” *Scientific American* 264 (1): 46–53 |
| 32                 | Batty, M., and P. A. Longley. 1994. *Fractal Cities: A Geometry of Form and Function*. Academic Press |
| 33                 | Dendrinos, D. S., and M. Sonis. 1990. *Chaos and Socio-spatial Dynamics*. Berlin: Springer |
| 34                 | Garreau, J. *Edge City: Life on the New Frontier* |
| 35                 | Benenson, I. 1998. “Multi-agent Simulations of Residential Dynamics in the City.” *Computers, Environment and Urban Systems* 22 (1): 25–42 |
| 36                 | Benenson, I. 1999. “Modeling Population Dynamics in the City: From a Regional to a Multi-agent Approach.” *Discrete Dynamics in Nature and Society* 3 (2–3): 149–70 |
| 37                 | White, R., and G. Engelen. 1993. “Cellular Automata and Fractal Urban Form: A Cellular Modelling Approach to the Evolution of Urban Land-use Patterns.” *Environment and Planning A* 25 (8): 1175–99 |
| 38                 | Phipps, M. 1989. “Dynamical Behavior of Cellular Automata under the Constraint of Neighborhood Coherence.” *Geographical Analysis* 21 (3): 197–215 |
| Number in Figure 4 | Title |
|-------------------|-------|
| 39                | Portugali, J., and I. Benenson. 1995. “Artificial Planning Experience by Means of a Heuristic Cell-space Model: Simulating International Migration in the Urban Process.” *Environment and Planning A* 27 (10): 1647–65 |
| 40                | Wu, F. 1996. “A Linguistic Cellular Automata Simulation Approach for Sustainable Land Development in a Fast Growing Region.” *Computers, Environment and Urban Systems* 20 (6): 367–87 |
| 41                | Batty, M., Y. Xie, and Z. Sun. 1999. “Modeling Urban Dynamics through GIS-based Cellular Automata.” *Computers, Environment and Urban Systems* 23 (3): 205–33 |
| 42                | Wagner, D. F. 1997. “Cellular Automata and Geographic Information Systems.” *Environment and Planning B: Planning and Design* 24 (2): 219–34 |
| 43                | Weidlich, W. 1987. “Synergetics and Social Science.” In *Lasers and Synaregetics*, edited by R. Graham and A. Wunderline. Berlin: Springer |
| 44                | Allen, P. M. 1997. *Cities and Regions as Self-organizing Systems: Models of Complexity*. Reading, UK: Gordon Breach Science |
| 45                | Makse, H. A., S. Havlin, and H. E. Stanley. 1995. “Modelling Urban Growth Patterns.” *Nature* 377 (6550): 608–12 |
| 46                | Prigogine, I., I. Stengers, and I. Prigogine. 1984. *Order Out of Chaos: Man's New Dialogue with Nature*, vol. 13. New York: Bantam Books |
| 47                | Kohonen, T. 1982. “Self-organized Formation of Topologically Correct Feature Maps.” *Biological Cybernetics* 43 (1): 59–69 |
| 48                | Clarke, K. C., and L. J. Gaydos. 1998. “Loose-Coupling a Cellular Automaton Model and GIS: Long-term Urban Growth Prediction for San Francisco and Washington/Baltimore.” *International Journal of Geographical Information Science* 12 (7): 699–714 |
| 49                | Dixit, A. K., and J. E. Stiglitz. 1977. “Monopolistic Competition and Optimum Product Diversity.” *The American Economic Review* 67 (3): 297–308 |
| 50                | Fujita, M., and P. Krugman. 1995. “When is the Economy Monocentric? von Thünen and Chamberlin Unified.” *Regional Science and Urban Economics* 25 (4): 505–28 |
| 51                | Krugman, P. 1991. “Increasing Returns and Economic Geography.” *Journal of Political Economy* 99 (3): 483–99 |
| 52                | Krugman, P. R. 1991. *Geography and Trade*. MIT Press |
| 53                | Coase, R. H. 1960. “The Problem of Social Cost.” *Journal of Law and Economics* 3 (1): 1–44 |
| 54                | Downs, A. 1994. *New Visions for Metropolitan America* |
| 55                | Granovetter, M. 1985. “Economic Action and Social Structure: The Problem of Embeddedness.” *American Journal of Sociology* 91 (3): 481–510 |
| 56                | Putnam, R. D. 2001. *Bowling Alone: The Collapse and Revival of American Community*. Simon and Schuster |
| 57                | Mandelbrot, B. B. 1983. *The Fractal Geometry of Nature/Revised and Enlarged Edition*. 495. New York: WH Freeman and Co. |
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### Appendix D

#### Table D1. Final Version of the Codebook.

| Conceptualization: |
|--------------------|
| Co_LocalInteractionLeadsToMacroPatterns |
| CO_PowerLaws |
| Co_PropertyOfComplexOpenSystems |
| Co_Self-Governance |
| Co_SOM |

| Factors enabling self-organization |
|-----------------------------------|
| F_AbsenceOfGovernment |
| F_AdaptationToLocalCircumstances |
| F_AdministrativeBoundaries |
| F_Age |
| F_AmountOfCustomers |
| F_AmountOfFirms |
| F_ArtCulture |
| F_Asymmetry |
| F_Autonomy |
| F_AvailableInformation |
| F_AvoidingSpillOverCosts |
| F_CarOwnership |
| F_ChangingServiceDemand |
| F_Children |
| F_CitySize |
| F_CivicEngagement |
| F_CognitiveUnderstanding |
| F_Commodification |
| F_CommonInterest |
| F_Communication |
| F_Commuting |
| F_Competition |
| F_Complexity |
| F_Connectivity |
| F_Consumption |
| F_Cooperation |
| F_CoordinationMechanism |
| F_Corruption |
| F_Cost |
| F_Creativity |
| F_Credibility |
| F_CrisisAndThreats |
| F_CulturalActivity |
| F_CulturalIdentity |
| F_Culture |
| F_DemographicCharacteristicsOfInstitutionalUnits |
| F_DependenceOnIndividuals |
| F_DesireForSelforganization |
| F_Discourse |
| F_Distance |
| F_Diversity |
| F_DiversityOfGoods |
| F_EconomicActivities |
| F_EconomicStatus |
| F_EconomiesOfScale |
| F_Education |
| F_Employment |
| F_Energy |
| F_EnforcementOfRules |

#### Table D1. (Continued)

| Factors enabling self-organization (continued) |
|-----------------------------------------------|
| F_Entrepreneurship |
| F_EstablishedCentres |
| F_Expenditure |
| F_Expertise |
| F_Exploitation |
| F_ExternalEffects |
| F_ExternalLinks |
| F_FinancialResources |
| F_FirstMoversAdvantage |
| F_FreedomOfChoice |
| F_FreedomOfEntryAndExit |
| F_FrictionOfDistance |
| F_FriendshipTies |
| F_Gender |
| F_GenerationOfInformation |
| F_GettingThingsDone |
| F_Globalization |
| F_GovernmentalDominanceOfProcess |
| F_GovernmentDecisions |
| F_GovernmentInability |
| F_Governments |
| F_GovernmentSpending |
| F_HerdingBehavior |
| F_HeterogenousEnvironment |
| F_Hierarchy |
| F_HomeOrientedActivity |
| F_Homogenization |
| F_HouseholdIncome |
| F_HousingMarkets |
| F_HousingProperties |
| F_Identity |
| F_Ideology |
| F_ImmobilityOfResources |
| F_Impatience |
| F_Incentives |
| F_Inclusiveness |
| F_Income |
| F_IndustryDevelopment |
| F_Inequality |
| F_InformalRelations |
| F_Information |
| F_InformationCompression |
| F_InformationDispersion |
| F_InformationSharing |
| F_InformationValidation |
| F_Innovation |
| F_InstitutionalBarriers |
| F_InstitutionalCapacity |
| F_InstitutionalEvolution |
| F_InstitutionalIncentives |
| F_Instructions |
| F_Interaction |
| F_InternalBonds |
| F_InternalFeedback |
| F_Investment |
| F_Jobs |
### Table D1. (Continued)

| F_KnowledgeIncrease          | F_Racial/SocialDiversity          |
|------------------------------|----------------------------------|
| F_KnowledgeSharing           | F_Recreation                     |
| F_LackOfGovernanceCapacity   | F_RedefiningRules                |
| F_Land Use                    | F_ReducedAccountability           |
| F_LandOwnershipRegime         | F_ReducedVarietyOfServices        |
| F_LandUseNotAllowed           | F_RelocationOfFirms              |
| F_Layout                      | F_Rent                           |
| F_Leadership                  | F_ResidentialSuccession           |
| F_Learning                    | F_ResistanceToLosingAuthority     |
| F_Legislation                 | F_ResourceAccessibility           |
| F_LessGovernmentInvolvement   | F_RestructurationOfNationState    |
| F_Lifestyle                   | F_Revenues                        |
| F_LimitedResources            | F_RiskAversity                    |
| F_LittleCivilInvolvement      | F_Risks                           |
| F_LocalInteraction            | F_SenseMaking                     |
| F_Location                    | F_Slope                           |
| F_MaritalStatus               | F_Slums                           |
| F_MarketCharacteristics       | F_SocialActivities                |
| F_Marketing                   | F_SocialConnectivity              |
| F_Markets/EconomicIncentives  | F_SocialExpanditure               |
| F_MarketSize                  | F_SpatialAssimilation             |
| F_Memories                    | F_SpatialCharacteristicsOfInstitutionalUnits |
| F_MergingWithNearbyClusters   | F_SpatialQuality                  |
| F_Migration                   | F_Spinoffs                        |
| F_MobilizationPeriod          | F_SportActivity                   |
| F_MonitoringAndFeedback       | F_SpreadingMotivation             |
| F_Myopia                      | F_Tax                             |
| F_Negligence                  | F_Technology                      |
| F_Negotiation                 | F_Time                            |
| F_Neighborhood                | F_Tolerance                       |
| F_Networks                    | F_Tourism                         |
| F_ObtainingVoice              | F_Tradition                       |
| F_Oppression                  | F_TransactionCosts                |
| F_PathDependency              | F_TransformationOfGoodsOrCapital  |
| F_PedestrianBehavior          | F_Transparency, Truthfulness & Respect |
| F_PedestrianSheds             | F_TransportationNetwork            |
| F_PlatformsForDelliberation   | F_TransportCosts                  |
| F_Policy                      | F_TravelDemand                    |
| F_PolicyGoals                 | F_Trust                           |
| F_PolicyWindow                | F_Turnover                        |
| F_PoliticalConditions         | F_TypeOfConflict                  |
| F_PoliticalHistory            | F_Unemployment                     |
| F_PoliticalDeals              | F_Uproar                          |
| F_PoliticalMotivations        | F_UrbanGrid                       |
| F_PoliticalPressure           | F_Urbanization                    |
| F_PoliticalStructure          | F_Variation                       |
| F_Population                  | F_VarietyOfProducts               |
| F_PopulationDensity           | F_Violence                        |
| F_PopulationGrowth            | F_WorkLocation                    |
| F_PopulationSaturation        | F_WorkOrientedActivity            |
| F_Poverty                     |                                  |
| F_Power                       | Issues or topics that self-organization is applied to: |
| F_Preference                  | I_CivilSociety / Civic Participation |
| F_Proceduralism               | I_CollectiveProblems             |
| F_production                  | I_CommunicationSystems            |
| F_PropertyRights              | I_CompetitiveCities              |
| F_PublicAnger                 | I_CulturalClusters               |
| F_QualityOfLife               | I_DistributionWithinCities       |

(continued)
Table D1. (Continued)

| Type of Paper:                                      |
|----------------------------------------------------|
| P_Empirical_Modeling/Simulation                    |
| P_Empirical_None                                   |
| P_Empirical_Qualitative                            |
| P_Empirical_Quantitative                           |
| P_Empirical_SOM                                   |
| P_Theoretical                                      |

| Results or effects of self-organization:            |
|----------------------------------------------------|
| R_Distribution_Cities                              |
| R_Distribution_Demographic                         |
| R_Distribution_Economic                            |
| R_Distribution_Logistical behavior                  |
| R_Economic_Profit                                  |
| R_Economic_Resilience                              |
| R_Economic_Transaction Costs                       |
| R_Information_Consensus                            |
| R_Information_Dispersion/Generation                 |
| R_Information_Framing                              |
| R_Information_Policy Support                        |
| R_Information_Uncertainty Reduction                 |
| R_Institutional_Civic Participation                 |
| R_Institutional_Collaborative Capacity              |
| R_Institutional_Power Structure                     |
| R_Institutional_Rule enforcement                    |
| R_Social_Cohesion                                  |
| R_Social_Freeriding/Hit-and-run/Conflict            |
| R_Social_Network Structure                          |
| R_Social_Trust/reciprocity                          |

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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