Master's Thesis – master Innovation Sciences

Frontrunner regions for urban sustainability experimentation in Europe: A quantitative approach

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Preface

"Frontrunner regions for urban sustainability experimentation in Europe: A quantitative approach" serves as my concluding piece of the master's program Innovation Sciences at Utrecht University, Department of Geosciences. I was engaged in writing this thesis from November 2018 to August 2019.

This master's thesis was undertaken with the aim to contribute to the PhD research of Harm van den Heiligenberg on sustainability experiments in Europe. I enjoyed the fact that I had the opportunity to contribute to a relatively unexplored research field, i.e. *the geography of transitions*. This allowed a lot of room for own interpretation and creativity. However, it also proved to be challenging to combine insights from various pieces of literature in a coherent and structured whole. In addition, limitations in the data demanded an exploratory and rather unusual approach towards finding meaningful patterns in the data. Nevertheless, I gained a lot of experience from conducting exploratory research and I hope that I contributed to a better understanding of the various local and regional context factors facilitating sustainability experimentation. The topic caught my interest from the very beginning and I can firmly say that I enjoyed it to the very end.

I wish to thank my supervisors Harm van den Heiligenberg and Gaston Heimeriks for their guidance and support during the process of writing the master's thesis. In particular, I appreciated the enormous enthusiasm with which Harm supported me during the process as well as his effort to help me deliver a paper that would complement his PhD work. Moreover, I am thankful to Gaston for his useful comments on how to design, structure and focus the paper, things that got me stuck many times. In addition, I would like to thank my second reader Frank van Rijnsoever for his constructive feedback on my research proposal and for grading the thesis. I am also grateful to Anna Davies and her SHARECITY research team, as the study would not have been possible without access to the SHARECITY100 Database.

I hope you enjoy this thesis.

Pim Verhagen

Utrecht, July 31, 2019

Abstract

This paper studies the geographically uneven distribution of sustainability experiments in Europe. It develops a conceptual model based on the synthesis of different pieces of literature to systematically analyse various demographic, socio-economic, and socio-cultural context factors. A better understanding of favourable context factors for sustainability experiments may help to explain why urban sustainability experiments emerge more in certain locations than in others. In doing so, it addresses the research gap of how spatial contexts affect the emergence, development and diffusion of urban sustainability experiments. The paper presents a first quantitative study to analyse sustainability experiments by drawing on a dataset of over 1200 urban food sharing experiments across 29 cities in Europe. Thereby, it complements existing qualitative studies on this topic.

Results suggest that urban food sharing experiments emerge, develop and diffuse in a variety of contexts. The paper shows that the number of food sharing experiments per capita is associated with a diverse set of favourable context factors, including technological specialisation, skilled labour, creative employment, cooperative culture, counterculture, place-reputation, openness, international meetings, quality of government and economic well-being, of which the latter two are novel contributions to the literature. In general, city-regions with a high number of food sharing experiments per capita (e.g. Berlin, Copenhagen, Dublin, London and Zurich) offer more favourable environments for urban sustainability experimentation than city-regions with a low number of food sharing experiments (Moscow, Naples and Thessalonica). It appears that the density of urban food sharing is higher in Northwestern Europe, in city-regions characterised by their devotion to sustainability and high quality of living. Interestingly, some city-regions such as Cologne have a high density of food sharing experiments but do not perform well on most of the context factors. The opposite applies to cities like Stockholm. Based on two brief case studies, the paper describes possible reasons for these contrasting findings.

The paper discusses the results and critically reflects on the usefulness of the conceptual model. Finally, the paper discusses its main limitations and argues that more research is needed on this topic. Future research avenues should focus on studying a larger sample of sustainability experiments, different types of experiments, differences within cities and the actual upscaling of experiments. Scholars are also invited to further develop the proposed conceptual model.

Keywords: *urban sustainability experiments, sustainability transitions, geography of transitions, geography of experimentation, food sharing*

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1. Introduction

There is growing concern that the current pattern of human consumption and production practices causes potentially irreversible environmental changes that would be disastrous for human well-being (Rockström, 2009). Wicked problems such as climate change, waste, hunger, and social injustice demand transitions towards more sustainable systems. The increasingly local and urban nature of (future) consumption and production practices has made the role of cities in the governance of sustainability transitions more and more important (Bulkeley and Castán Broto, 2013; Hämäläinen, 2015; Voytenko et al., 2016). This awareness has led to a growing interest among geographers in the role of cities in the governance of sustainability transitions (Bulkeley et al., 2010).

According to sustainability transitions literature, a first step to support the transition towards more sustainable systems is to experiment with sustainability innovations (Berkhout et al., 2010; Geels, 2002; Kemp et al., 1998; Schot and Geels, 2008). A series of successful experiments may contribute to an upscaling trajectory in which an experiment is diffused to other locations, potentially leading to changes in dominant practices on the long-term (van den Heiligenberg et al., 2017). Crucial for understanding the emergence of sustainability experiments are spatial context factors (Smith et al., 2010; van den Heiligenberg et al., 2017, 2018).

Traditionally, however, there has been a neglect of this spatial dimension in the transition literature (Coenen et al., 2012; Coenen and Truffer, 2012; Smith et al., 2010). Until now, it remains largely unclear how different local and regional context factors affect the emergence, development and diffusion of urban sustainability experiments (Håkansson, 2019; Van den Heiligenberg et al., 2018). This spatial dimension is important to consider since such experiments are distributed unevenly across space; in some places they emerge more and diffuse easier to other locations (Boschma, 2005; Hansen and Coenen, 2015). More recently, scholars have begun to study this topic in an upcoming research field: *the geography of transitions* (Truffer and Coenen, 2012). First attempts have been made to investigate the spatial factors through which regions become favourable environments for sustainability experimentation (Longhurst 2015, Raven et al., 2017, van Heiligenberg et al., 2017, Torrens et al. 2018a). It is suggested that regions require both: (1) an adequate *habitat* for experimentation, defined as the configuration of the most important spatial context factors *facilitating the emergence and development* of sustainability experiments; and (2) a supportive *harbour*, defined as the configuration of favourable context factors *supporting the diffusion* of sustainability experiments to other locations. The underlying assumption is that different types of experiments may prosper in specific habitats and harbours (Van den Heiligenberg et al., 2017).

This paper engages specifically with urban food sharing, which represents an important and representative case for understanding the spatial distribution of sustainability experiments. Urban food sharing is increasingly being identified as a means for cities to support the transition towards more sustainable urban food systems. Especially in Western countries, where food is wasted because of overstocking, conservative consumption guidelines and consumer habits (Weymes and Davies, 2018), food sharing can contribute to reducing food consumption, redistributing surplus food and preventing food waste (Davies and Evans, 2018; Rut and Davies, 2018). As a result, thousands of urban food sharing initiatives have emerged worldwide (Davies et al., 2017b).

Urban food sharing initiatives can be conceptualised as sustainability experiments in niches which support the transition towards more sustainable food systems. Following Matschoss and Heiskanen (2017), they are experimental if *1) they are planned and purposive, but specifically aim to*

learn and gain experience from testing new ideas and methods (Castán Broto and Bulkeley, 2013; Sengers et al., 2016). The aggregation of lessons learnt from these initiatives may contribute to an upscaling trajectory which might potentially lead to changes in the dominant regime; *2) their underlying idea radically differs from existing ways of providing food in urban contexts*. In other words, they have the potential to disrupt urban food systems; *3) they have some form of influence beyond the experiment.* If urban food sharing initiatives are to contribute to a transition, they require diffusion to other locations. Although urban food sharing initiatives can be valuable if they only fulfil the first two criteria, they should have an impact beyond the people involved in the experiment to be able to contribute to a more sustainable food system.

Based on economic geography and RIS literature, which describe how some regions or cities are pioneers in terms of economic activity and innovation (Asheim and Gertler, 2006; Florida, 2005), the question arises whether there are also regions which can be regarded as frontrunners in facilitating urban food sharing experiments. Frontrunner regions are expected to exhibit a configuration of spatial context factors which is favourable for the emergence, development and diffusion of urban food sharing experiments. Hence, they are expected to host a relatively large number of experiments compared to other regions.

This paper explores the spatial context factors favourable for sustainability experimentation using the following research question: *What local and regional context factors might explain why certain city-regions in Europe are frontrunners in urban food sharing experimentation?* Several steps are taken to answer this question. The first step is to extract favourable factors for sustainability experimentation from the literature. The second step is methodological and aims to translate these factors into indicators which can help to explain patterns in urban food sharing experimentation. The third step presents the results; it provides a description of the indicators that significantly correlate with the number of food sharing experiments per capita and identifies general patterns. The fourth step critically reflects on the findings. It critically reviews the adequacy of the conceptual model and discusses the limitations of the indicators that were used in the analysis. Lastly, two brief case studies are presented to complement contrasting findings from the quantitative analysis.

To better understand how distinct environments facilitate different types of food sharing experiments, this paper presents a first quantitative study of the relationship between sustainability experiments and their local and regional context. Empirically, the study draws on a dataset of 1237 urban food sharing experiments across 29 European cities (SHARECITY100 Database). All experiments are enabled by ICT, referring to web pages, blogs, social media, smartphones, and apps.

By focussing on Europe this paper captures: a) the heterogeneity of urban environments and its associated strategies to experimentation (Cortinovis, 2017; Håkansson, 2019); b) the uneven spatial distribution of different transition processes (Bridge et al., 2013; Hansen and Coenen, 2015); and c) the various history and place-dependent developments across European countries (Kotzeva et al., 2016).

This paper aims at making two scientific contributions. Theoretically, it addresses the research gap by contributing to the growing body of work on the geography of transitions. It seeks to bring greater coherence to our understanding of the spatial context factors through which regions become favourable environments for sustainability experimentation. Methodologically, the paper complements the existing range of qualitative studies by employing a first quantitative approach to analyse sustainability experiments in Europe, using data on a local and regional scale. By making a first attempt at translating local and regional context factors into indicators that may discern distinct

favourable contexts for food sharing experimentation, the paper seeks to identify what factors explain the incidence of food sharing experiments.

At the moment there is hardly any scientific insight available on why different kinds of sustainability experiments emerge more and develop better in some locations than in others. A better understanding of this would provide regional stakeholders (e.g. policymakers, local and regional governments) involved in urban food sharing experimentation with relevant insights that may help them to enhance the success of experiments on the long-term.

The paper proceeds as follows. Section 2 provides a review of the habitat and harbour concepts and develops a conceptual model. Section 3 presents a case description of urban food sharing. Section 4 specifies the methodology, the variables used and the indicators proposed. Section 5 presents the findings of the analysis and discusses its implications for the conceptual model. Section 6 complements the findings of the analysis by providing short informative case studies of two contrasting city-regions. Section 7 discusses the paper's main contributions, its limitations, future research avenues and policy implications and recommendations. Lastly, Section 8 presents some concluding remarks.

2. Conceptual model

This section elaborates on the habitat concept and its role in facilitating the emergence and development of sustainability experiments. Subsequently, it outlines the harbour concept and its role in supporting the diffusion of sustainability experiments to other locations. Based on a review of both concepts, hypotheses are formulated and a conceptual framework is developed. In addition, the section proposes an extension of existing literature. In doing so, this section aims to provide more structure and coherence in the heterogeneity of spatial context factors facilitating sustainability experimentation.

2.1. Habitats

Several concepts have been proposed to describe the specific configuration of local and regional context factors facilitating urban experimentation, such as seedbeds, fertile soil and habitats. This research builds on the habitat concept since it suggests that experiments are carried out in co-evolution with its geographical context (Van den Heiligenberg et al., 2017).

The habitat concept is based on the niche concept, stemming from the strategic niche management (SNM) literature. Similar to the niche concept, a habitat offers a protective space for experimentation which is temporarily isolated from influences of the dominant regime (Schot and Geels, 2008). However, the niche concept does only implicitly deal with spatial dimensions. Furthermore, city-regions may host several distinct habitats simultaneously, which implies that habitats may overlap geographically (van den Heiligenberg et al., 2017).

Yet, little is known about the factors that facilitate different types of experiments. Van den Heiligenberg et al. (2017) developed a typology of sustainability experiments in four distinct habitats based on the types of experiments that flourish within these habitats (see Fig. 1). The framework distinguishes between two dimensions which have been differentiated for analytical purposes. The framework's vertical axis is formed by the *governance* dimension. On the one hand, guided experiments are governed top-down by firms or governments and are characterised by clear leadership through *visioning* (Kemp et al., 1998). On the other hand, grassroots experiments are governed bottom-up by voluntary associations, activists and citizen groups and show no clear leadership and protocol for learning (Van den Heiligenberg et al., 2017). The horizontal axis is formed by the *knowledge* dimension and is based on the hypothesis that the type of knowledge involved varies widely between experiments depending on technological innovation and experiments primarily focussed on social innovation.

The relative importance of technological and social innovation differs greatly among experiments. *Experiments for technological innovation* deal with the creation of new and application of existing technologies (Pesch et al., 2019). They rely on scientific research and mainly produce codified knowledge (Asheim et al., 2007). Furthermore, they may flourish in science-based neighbourhoods (Spencer, 2015). Experiments for technological innovation often deal with energy and transportation issues such as range prediction systems for electric vehicles, home energy monitoring, off-grid solar PV energy and Bus Rapid Transport (BRT) systems (see for example Van den Heiligenberg et al., 2017; Jolly et al., 2012 and Sengers and Raven, 2015).

Experiments for social innovation deal with institutional, behavioural and cultural change and mainly produce tacit knowledge. In essence, they aim to provide alternatives to dominant institutionalised routines and practices (Bulkeley and Castán Broto, 2013; Howaldt and Schwarz, 2010).

Experiments for social innovation may focus on three dimensions: (1) addressing unsatisfied human needs, (2) changing social relations to increase levels of participation of deprived groups in society, and (3) increasing the capability and access to resources (Moulaert, 2005). Ceschin (2014) notes that the application and diffusion of social innovations are still very limited. The reason is that they require fundamental changes in dominant socio-technical regimes (e.g. changes in norms, values, routines, behaviours, rules and regulations) (Geels, 2002). Specifically, they require the breakdown of routinised behaviour of individuals. However, this is beyond the control of one single actor; it requires collective action and therefore it is difficult to achieve (Ceschin, 2014; Moulaert et al., 2013). Experiments for social innovation often deal with alternative modes of production and consumption (Pesch et al., 2019), including the sharing economy (e.g. food sharing), alternative housing, urban agriculture and alternative monetary systems (see for example Håkansson, 2019 and Nicolosi et al., 2018) and may flourish in creativity-based neighbourhoods (Spencer, 2015).

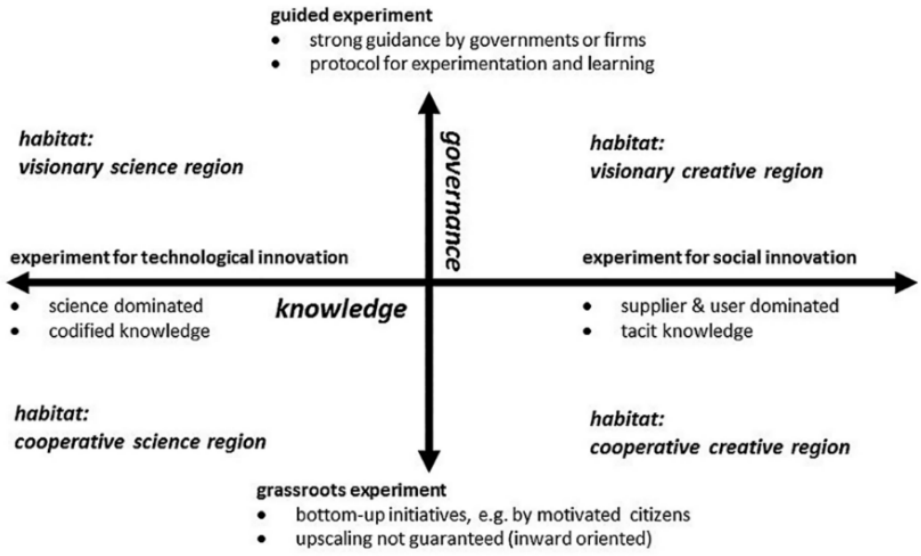


Fig. 1. Typology of sustainability experiments in their favourable habitats (Van den Heiligenberg et al., 2017).

Building on the typology presented in Fig. 1, Van den Heiligenberg et al. (2018) identified four distinct habitats for sustainability experimentation through in-depth case studies and a review of transitions- and RIS literature (see Fig. 2). Each habitat is characterised by specific patterns of spatial context factors, which are built up of the following five dimensions: type of knowledge, type of governance, informal localised institutions, regional innovation advantages, and social learning dynamics. The framework is the result of a first attempt to map which local and regional context conditions support different types of sustainability experiments. Although it has not been validated yet whether the suggested archetypical experimentation patterns are also observed with other sustainability experiments and in other locations in Europe, it provides a useful overview of factors potentially favourable for food sharing experimentation. However, Van den Heiligenberg et al. (2018) do not fully explicate the mechanisms underlying the different context factors. Therefore, these are briefly described below.

Experiments for technological innovation may flourish in a *science-based campus milieu*. A science-based campus milieu refers to any type of high-tech cluster such as a science park, science and technology park, innovation centre or R&D park, which aims to stimulate economic growth and

innovation within a region (UNESCO, 2019). Here, the co-location of firms and strong links with universities may result in knowledge spillovers which may stimulate innovation (Díez-Vial and Montoro-Sánchez, 2016). Silicon Valley is an iconic example of a science-based campus milieu. Science-based campus milieux can be found in regions with *technological specialisation*. In such regions high-tech employment tends to be concentrated in only a few sectors (e.g. aviation, communication technology, biotech and semiconductors), R&D spending is high and the majority of patents granted belong to a small number of firms specialising in one or more technologies (Cortright and Mayer, 2001). Experiments for technological innovation may flourish in habitats with a campus milieu and a specialisation in technology.

According to RIS literature, regions with a pool of *skilled labour* have a higher absorptive capacity than regions with lower education levels and are therefore better able to assimilate and utilise knowledge being diffused through global pipelines (Fitjar and Rodríguez-Pose, 2015). These regions tend to be more open-minded and receptive to ideas from the outside world and are more likely to engage in international collaborations (Fitjar and Rodríguez-Pose, 2015). Accordingly, such regions are attractive to any firm, especially firms in innovative and technology-based industries (Florida, 2002a). For these reasons, a pool of *skilled labour* is thought to be favourable for sustainability experiments.

The term *counterculture* originates from the 1960s and is generally defined as a sociopolitical movement of a young and educated middle class which challenges the values and goals of capitalism (Longhurst, 2013). Longhurst (2015) describes how a local concentration of countercultural institutions and practices shapes a protective space for sustainability experimentation trough openness towards radical ideas, spatial imaginaries and self-transformation (Longhurst, 2015). Van den Heiligenberg et al. (2018) found that countercultures in the upper quadrants mainly comprise young people with a focus on community building and alternatives lifestyles, while in the lower quadrants they are characterised by a strong resistance against the mainstream.

RIS literature also emphasises the role of *creativity* – particularly the creative class, i.e. knowledge workers, professional artists, writers, and performers – as a driver of regional growth and innovation (Florida, 2002b). Sleuwaegen and Boiardi (2014) note that workers in creative occupations are the main source of inspiration for the generation and diffusion of new ideas in patented knowledge. An underlying mechanism explaining this relationship comes from supply chain linkages between creative industries and other economic industries, which facilitate knowledge spillovers. Moreover, the authors show that creative workers have a far stronger impact on regional innovation than highly educated workers. In relation to sustainability experimentation, Van den Heiligenberg et al. (2018) found that creativity was emphasised in all cases to be an important cultural factor in facilitating sustainability experiments.

A *cooperative culture* is characterised by a strong community feeling of sharing and collaboration. In general, cooperative regions may be more likely to subsidise R&D cooperation, which has been shown to stimulate the innovation efficiency of regions (Broekel, 2015). In relation to sustainability experimentation, a cooperative culture may enable the transfer of knowledge through regional networks and contributes to mutual learning (Capdevila, 2018). Especially the exchange of tacit knowledge and skills, argued to be important for grassroots experiments, is stimulated by a cooperative culture (Van den Heiligenberg et al., 2018). Another advantage is that members of a cooperative relationship are better able to supply appropriate information to each other because they better understand the needs of their partners (Fritsch and Lukas, 1999).

Since each region is involved in different *local and regional networks* related to sustainability experimentation, it is nearly impossible to study the role of these networks for different habitats in a

systematic and quantitative manner. Therefore, local and regional networks are not further incorporated into this research. However, *global networks* are included, as a harbour factor.

Fig. 2. Archetypical experimentation patterns in four habitats (adapted from Van den Heiligenberg et al., 2018).

The framework in Fig. 2 focusses on experiments for technological and social innovation. Food sharing experiments can be described as experiments for social innovation because they aim to find innovative solutions to societal challenges and contribute to behavioural change (Van den Heiligenberg et al., 2017). Therefore, it is expected that the habitats which host experiments for social innovation (Middleground and Do-it-ourselves) are more favourable for the emergence and development of urban food sharing experiments than the habitats which host experiments for technological innovation (Valley and Makerspace). Moreover, it is expected that urban food sharing flourishes in the habitats favourable for grassroots innovation (Makerspace and Do-it-ourselves) than in the habitat favourable for guided experiments (Valley and Middleground). Hence, the following two hypotheses are formulated:

Hypothesis 1a. The density of urban food sharing experiments is higher in city-regions which host a habitat which facilitates experiments for *social innovation* (instead of experiments for technological innovation).

Hypothesis 1b. The density of urban food sharing experiments is higher in city-regions which host a habitat that facilitates *grassroots experiments* (instead of guided experiments).

By testing these hypotheses, the paper attempts to provide clarity on the usefulness of the typology presented in Fig. 1.

2.2. Harbours

The harbour concept is underpinned by literature on transnational linkages (Wieczorek et al., 2015), cosmopolitanism (Blok, 2014), port cities (Blok and Tschötschel, 2016), policy mobility (Blok, 2012; Peck and Theodore, 2010) and global pipelines (Bathelt et al., 2004). These theories regard local urban contexts as central hubs for the diffusion, flow and movement of knowledge, policies and innovations within the same or to other contexts. This paper extends the current conceptualisation of such hubs and suggests that a harbour *supports the diffusion* of sustainability experiments. A harbour may act both as a departing and receiving region for the diffusion of urban sustainability experiments.

Following Peck and Theodore (2010), who argue that mobile policies are diffused in bits and pieces, it is assumed that only a part of the experiment or the conceptual idea behind it is transferred to other contexts. In addition, Wieczorek et al. (2015) use the concept of transnational linkages to describe that actor, knowledge, capital, institutional and technology-related aspects of sustainability experiments can be transferred. Especially actors are crucial for the transfer of the other aspects since they are considered the *carriers* of knowledge, capital, institutions and technology. Along the same line, Breschi et al. (2010) state that "knowledge always travels along with people who master it" (pp. 17).

According to Torrens et al. (2018a), harbours arise from path-dependent developments based on favourable spatial factors and, consequently, develop distinct cultures over time (e.g. multicultural, tolerant to diversity, cosmopolitan). From the abovementioned strands of literature, several of such favourable spatial factors can be identified (see Table 1). According to Torrens et al. (2018a) *place-reputations (e.g. green, creative and entrepreneurial) and reputations of powerful local actors* are crucial to attracting like-minded individuals, mobile experts, knowledge, resources and capital. Furthermore, place-reputations may provide access to communication channels for knowledge exchange and may foster competition and cooperation with other cities. Networks of consultants, mayors, journalists, but also city networks, prizes and the sharing of best practices actively contribute to building such reputations (Torrens et al., 2018a). McCann (2013) showed that cities use these place-reputations to shape national policy. This development is especially relevant for countries where municipalities tend to have little formal power.

Second, a region characterised by *openness* may signal that it is receptive to radical ideas which may stimulate others to experiment with radical innovations in these areas. This is outlined in a study on sustainability experimentation in Totnes (UK): "(…) there was an openness to such ideas within the locality. This openness was regarded as an important factor in explaining why Totnes has become a site of experimentation across a range of different areas" (Longhurst, 2015, pp. 190). In general, openness may generate access to external influences, trends, ideas and so on that may provide valuable information and lessons to those involved in sustainability experimentation. Additionally, Florida (2002b) argues that a significant concentration of specific subcultures (Bohemia) in a region indicates an environment that is open to talented and creative people. These high human capital individuals may increase the level of innovation and creativity within a region.

In line with González-López and Fernández-Montoto (2018), this study distinguishes between intercultural and scientific & technological (S&T) openness. Firstly, intercultural openness refers to a society's tolerance towards foreign cultures and societies. It is similar to Florida's tolerance but refers more broadly to the capacity of a region to attract ideas from outside. Intercultural openness may act as a mechanism to absorb mainly tacit knowledge into the region and may, therefore, be more advantageous for social innovation. Secondly, S&T openness refers to the interaction of universities, research centres and companies more directly related to innovation. S&T openness may work as a mechanism to incorporate mainly codified knowledge into the region and may, therefore, be more advantageous for technological innovation.

Third, through *transnational municipal networks* (TMNs) knowledge of sustainability experiments is spread across a variety of spatial contexts (Williams, 2017). TMNs aim to share expertise and policy know-how on sustainability issues, often through the communication of best practices (Kern and Bulkeley, 2009). Initiatives participating in TMNs may benefit from the support of other initiatives and the ability of the networks to articulate general lessons derived from experiences elsewhere (Feola and Butt, 2017). Research suggests that port cities appear to have a higher tendency than non-port cities to participate in TMNs such as ICLEI and C40, which may be caused by a greater concern with the risks of climate change (Blok and Tschötschel, 2016).

Fourth, Feola and Butt (2017) suggest that *international meetings*, such as fair trade fairs and conferences support the diffusion of sustainability initiatives. They confront places with knowledge and practices from different parts of the world and strengthen their global pipelines (Cohendet et al., 2010; Maskell et al., 2006). More specifically, such events allow face-to-face interaction and thereby facilitate the exchange of tacit knowledge, skills and ideas. This is especially relevant for social innovations (including food sharing initiatives), as they mainly involve tacit knowledge.

Lastly, *funding* is often mentioned to be a crucial factor for the development and upscaling of sustainability experiments. Van den Heiligenberg et al. (2017) found that a lack of funding represents the most important barrier to the success of sustainability experiments. This was especially perceived in the Valley and Makerspace habitats, both favourable for technological innovation.

Table 1. A proposed list of spatial factors supporting the diffusion of sustainability experiments.

Dimension	Factors	Source
Regional advantages	Reputations of cities (e.g. green, digital, sustainable) and powerful local actors (leading universities, well-established firms)	Bathelt et al. (2004); Feola and Butt (2017); Sengers and Raven (2015); Torrens et al. (2018a)
Culture	Openness (to innovation and to other cultures), tolerance and trust	Bathelt et al. (2004); Florida (2002a; 2002b); Landry (2012); Longhurst (2015); Sengers and Raven (2015); Torrens et al. (2018a); Van den Heiligenberg et al. (2017, 2018)
Networking	Transnational Municipal Networks (TMNs); global city networks; Global Intelligence Corps	Blok and Tschötschel (2016); Feola and Butt (2017); Hakelberg (2014); Kern and Bulkeley (2009); Landry (2012); Torrens et al. (2018b); Williams (2017).
	International meetings	Bathelt et al. (2004); Capdevila (2018); Cohendet et al. (2010); Feola and Butt (2017)

Capital	Availability of funding from public and private sector	Cooke et al. (1997); Jolly et al. (2012); Matschoss and Repo (2018); Torrens et al. (2018b); Van den Heiligenberg et al. (2017, 2018); Wieczorek et al., 2015

While some of the factors described in Table 1 relate to the diffusion of sustainability experiments, others apply specifically to grassroots initiatives, and still others focus solely on the dissemination of knowledge. Because it has not been examined whether these factors show clear differences between distinct spatial contexts (read habitats), the abovementioned factors are included for all four habitats. This leads to the following hypothesis:

Hypothesis 2. The density of urban food sharing experiments is higher in city-regions which host favourable harbour conditions.

This paper proposes that, for a region to be a frontrunner regarding sustainability experimentation, both favourable habitat and harbour conditions are required. However, integrating them could prove to be difficult considering their contradictory nature. On the one hand, habitats are *isolated spaces* and require active nurturing and protection from dominant regime pressures. On the other hand, harbours require *openness* to the outside world. For this reason, this research studies them separately.

2.3. Proposed additions to the framework

Besides the habitat and harbour factors described above, this paper underlines the importance of other factors which are likely to influence sustainability experimentation but which do not necessarily relate to the habitat and harbour concepts. Firstly, the paper introduces 'quality of government'. The reason to include this factor stems from RIS literature. In Regional Innovation Systems, institutional arrangements are fundamental for creating an innovative ecosystem. Regional governments play an import role in facilitating these arrangements. Rodríguez-Pose and Di Cataldo (2015) show that ineffective and corrupt governments constitute a crucial barrier when stimulating the innovative performance of less-developed EU regions. Moreover, quality of government has proved to significantly contribute to environmental sustainability. Policies and institutions developed by the government may help to create favourable conditions for a greener economy by reducing investment costs and increasing knowledge production (Tapia et al., 2014).

In relation to urban sustainability experimentation, local governments may support sustainability experimentation by providing, among others, funding, room for experimentation, and access to regional networks (Van den Heiligenberg et al., 2018). However, this requires strong institutional arrangements and an effective and transparent local and regional government. Therefore, it is expected that a high quality of government is favourable for the emergence, development and diffusion of sustainability experiments. Especially for the upper quadrants of Fig. 2, where experiments are mostly guided by governments, this factor is expected to be even more important.

Hypothesis 3a. The density of urban food sharing experiments is higher in city-regions which are characterised by a high quality of government.

Secondly, regions characterised high levels of economic well-being are likely to make more resources available to improve social, environmental and economic sustainability within the region. It

is useful to examine the role of economic well-being given the great variety in prosperity levels between large cities and rural areas.

Hypothesis 3b. The density of urban food sharing experiments is higher in city-regions which are characterised by high levels of economic well-being.

Both quality of government and economic well-being are different from the habitat and harbour factors described above as they are important for the emergence, development as well as the diffusion of sustainability experiments. However, it is difficult to point out in what way both factors influence sustainability experimentation given the complex or abstract effects of both factors. To give an example, the connection between alternative lifestyles and the emergence of community-based food experiments is much more obvious and direct than the link between the quality of government and the emergence of sustainability experiments.

Thirdly, internet penetration rate is introduced specifically because it is expected that ICT-mediated food sharing initiatives are better supported in regions where a large proportion of the population has access to the internet at home.

Hypothesis 3c. The density of urban food sharing experiments is higher in city-regions which are characterised by a high internet penetration rate.

2.4. A representation of the conceptual model

Fig. 3 presents a conceptualisation of distinct favourable contexts for food sharing experiments and its underlying mechanisms. It shows the four archetypical habitats characterised by their own specific configuration of favourable spatial context factors for experimentation (represented by the gear icons). As suggested by the overlap of the habitats and the harbour diamond, a harbour can be part of a habitat. The diagonal arrows of the harbour diamond present the diffusion of actor, knowledge, capital, institutional and technology-related aspects of sustainability experiments (represented by the four icons, respectively) between different habitats. This diffusion is made possible by the favourable harbour factors. Besides habitat and harbour factors, additional factors are included in the figure which do not belong to one specific habitat. All favourable factors are located in a bounded geographical space, symbolised by the outer circle. The arrows pointing towards ‘food sharing experimentation’ represent the formulated hypotheses.

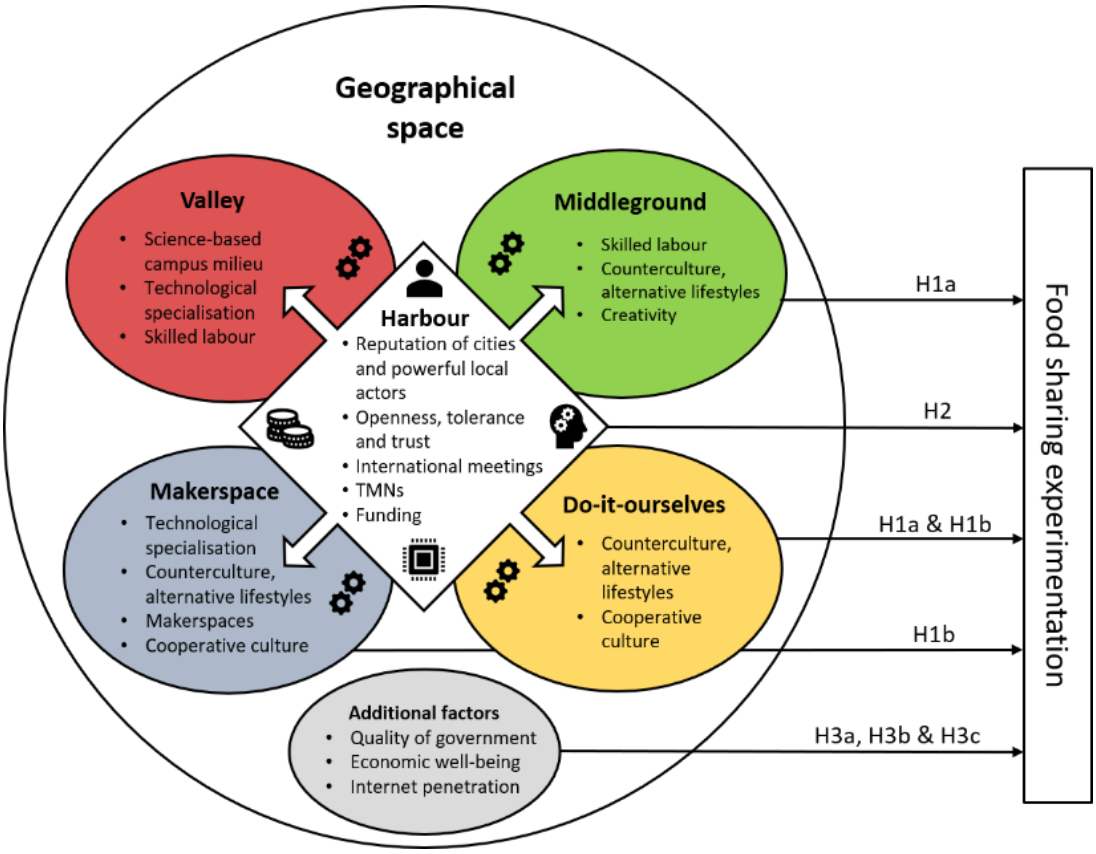


Fig. 3. A conceptualisation of distinct favourable contexts for food sharing experimentation.

3. The case of urban food sharing

Urban food sharing offers useful data to study the geographically uneven distribution of sustainability experiments. Experimentation with food sharing in urban areas may support the transition towards more sustainable urban food systems while at the same time reducing food consumption and preventing food waste (Davies and Evans, 2018; Rut and Davies, 2018). Evidence suggests that urban food sharing experiments, like sustainability experiments, are geographically unevenly distributed. This may be caused by local and regional context factors.

Marsden and Sonnino (2012) note that food holds specific geographical features since its production and consumption encompass essential natural and metabolic processes that depend on the resources (mainly financial capital) available in the region. Accordingly, "food systems – and their health and wellbeing attributes – inherently interact with (and shape) spaces and places" (pp. 427). Moreover, Feola and Nunes (2014) use insights from social movement theory and transition studies to argue that the geography of grassroots movements matter. They suggest that direct interaction between transition initiatives, facilitated by geographical proximity, is an important factor for the success of grassroots innovations. Feola and Butt (2017) add that geographical proximity may facilitate various types of interaction that lead to the diffusion of grassroots movements.

In light of the above, it is expected that some city-regions are better able than others to develop urban food strategies for more sustainable food systems. Evidence suggests that this might be the case. Based on two case studies of Bristol (UK) and Malmö (Sweden), Moragues-Faus and Morgan (2015) describe which factors caused both cities to become urban food pioneers. On the one hand, Bristol's *skill profile, vibrant food culture* and *green urban civil society* made it the first city in the UK to establish a food policy council and the first British city to win the European Green Capital award. On the other hand, Malmö's *strong political commitment (caused by an intrinsic motivation to be completely sustainable), its informal collaborative culture* and *involvement of food champions and civil society initiatives*, made it a frontrunner in sustainable urban food.

Only recently, scholars began to study food sharing as a means to contribute to more sustainable food systems (Davies et al., 2017b; Davies and Evans, 2018; Davies and Legg, 2018; Edwards and Davies, 2018; Marovelli, 2018; Michelini et al., 2018; Morrow, 2018). However, research on this topic is still sparse. Davies et al. (2017b) found that ICT-mediated food sharing initiatives are unevenly distributed across space and often cluster around a small number of highly active cities. They argue that cities which exhibit a high number of experiments per capita are characterised by a *historic commitment to food and agriculture* and *strong links with university towns*. *Charismatic champions* who lead the way, *membership of international city networks* (e.g. Sharing Cities Network), *a supportive governing structure* for food and sustainability-related activities and the *availability of internet connections* are also mentioned to be important factors. Furthermore, Edwards and Davies (2018) show that Melbourne's *unique physical conditions* and *long-lasting history of agriculture* have led to a favourable context which fosters a landscape of community gardens, urban farms, and community growing programmes. Moreover, based on a case study of Singapore, Rut and Davies (2018) show that the scale-up of sustainable food initiatives largely depends on the socio-political context. Especially *strong government support* was found to be a crucial factor.

When comparing the favourable spatial factors described in this section with the factors described in Section 2 and Section 3, some similarities can be identified. Table 2 presents a brief overview of the similarities between sustainability experiments and food sharing experiments. This

confirms that the favourable spatial factors for sustainability experiments to a great extent correspond to the favourable spatial factors for urban food sharing experiments.

Table 2. Similarities between factors important for both sustainability and food sharing experiments.

Dimension	**Sustainability experiments**	**Food sharing experiments**
Governance	Top-down and bottom-up government support	Supportive governing structure
Regional advantages	Powerful local actors (leading universities, well-established firms) Reputation of cities (e.g. green, digital, sustainable)	Charismatic champions who lead the way Historic commitment to food and agriculture
Networking	Transnational municipal networks (TMNs); global city networks; Global Intelligence Corps	Membership of international city networks (e.g. Sharing Cities Network); strong links with university towns; ICT (apps, websites, platforms etc.)

4. Methodology

This section describes the methodology and variables that were used to test the hypotheses. The analysis focused on the relationship between the number of urban food sharing experiments and spatial context factors across 29 cities in Europe.

4.1. Research design and data collection

This study is of exploratory nature and employs a mixed-methods research design. The study's main approach is of quantitative nature and aims to identify what favourable context factors might explain why certain regions are frontrunners in sustainability experimentation based on the analysis of a set of indicators. These indicators were based on factors identified in the literature and were examined to test the mechanisms of the conceptual model. In turn, two brief case studies were provided to complement contrasting findings from the quantitative analysis. Data for the quantitative analysis were collected through two types of databases:

1) Databases which contain regional indicators in Europe (e.g. demographic and socio-economic indicators). A database was built containing indicators which represented favourable factors for food sharing experimentation. An overview of the database methodology can be found in Appendix A. The indicators were collected for each of the 29 European cities within the SHARECITY100 Database. Representative indicators were primarily collected on city level. However, due to the lack of local (city) data, indicators were also collected on regional level (NUTS 3 and NUTS 2) and national level. Since multiple data sources were used, it was not possible to collect all indicators from the same year.

2) The SHARECITY100 Database, which contains 3835 ICT-mediated food sharing initiatives worldwide, of which 1237 initiatives across 29 cities in Europe (Davies et al., 2017b). Based on a typology of food sharing (see Davies and Legg, 2018; Davies et al., 2017a), the database describes what type of food is shared, how it is shared and by what type of organisation. The forms of ICT required for the initiative to be included in the database were: a website, a Facebook page, a meet-up or twitter profile, app or platform. This requirement ensured that online searches were in theory able to identify the entire population of ICT-mediated food sharing initiatives worldwide. The building of the database began in 2014-2015 with a scoping study using English keyword searches which identified 492 individual food sharing initiatives within 188 cities and 27 countries (Davies and Legg, 2018). A thorough analysis was then conducted from April 2016 to August 2016[1]. Five urban networks and indices were used to assist in the city selection: The Sharing Cities Network, 100 Resilient Cities Network, The Milan Urban Food Policy Pact, A.T. Kearney Global Cities Index, and the Economist Competitive Cities 2015 list. Through this process, 404 cities were identified. The final selection of 100 cities included all 54 cities involved in the Sharing Cities Network in 2016 and the top-ranked cities across the other indices. Initiatives were collected through (1) a systematic multilingual search – using 28 key search terms identified by the research team, food sharing networks, communities and activists – via country-specific Google search

[1] For more in-depth information about the building process of the final database see Davies et al. (2017a) and Davies et al. (2017b). For more information about the scoping study see Davies and Legg (2018).

engines, social networking sites such as Twitter and Facebook, networks of food activists, sharing networks, solidarity economy organisations, and international research networks, and (2) open calls for suggestions of initiatives through a range of food-related lists and networks. The eligibility of the identified initiatives was determined through debate within the research team. Eventually, a total of 4003 initiatives were identified worldwide and coded by the research team, of which 3835 were included in the database. Appendix B provides an overview of the cities that are included in the database and Appendix C describes the regional density of urban food sharing experiments in Europe.

The following sections describe the variables and indicators included in the analyses. A detailed overview of their operationalisation is presented in Appendix D.

4.2. Dependent variable

The study's dependent variable is the *Number of urban food sharing experiments per capita*, also referred to as the 'density of food sharing experiments' in this paper. The variable assumes that the number of food sharing experiments will be higher if the local and regional context factors are favourable. It is expected that the number of experiments will be higher for an urban food sharing experiment if it fits with the habitat favourable for that type of food sharing experiment. To deal with the variety in regional levels of the indicators, the dependent variable was calculated on city, NUTS 3 and NUTS 2 level. Subsequently, indicators were matched to the dependent variable at the same territorial level.

4.3. Operationalising favourable factors for sustainability experimentation

This section proposes a set of indicators to operationalise the favourable spatial factors for sustainability experimentation as presented in Fig. 2 and Table 1 of Section 2. Before continuing, it is important to shortly address the limitations of using indicators for empirical research. Firstly, it can be questioned to what extent an indicator actually is an adequate measure of a concept. For example, patents are generally used as indicators for innovation. However, patents refer more to invention than innovation, since many patents are never even commercialised. As the name suggests, an indicator provides an indication of a concept, not the actual concept. Secondly, a significant correlation between an indicator and a concept provides evidence that both are related. However, an indicator does not provide an explanation for the underlying mechanisms which determine this relationship. This explanation is often far more complex. While technological indicators such as patents and R&D investment are commonly used indicators for measuring a region's innovative capacity, no such commonly used indicators yet exist for measuring the emergence, development and diffusion of sustainability experiments. This is where this paper aims to fill the gap.

The proposed indicators were selected based on three criteria:

1) *Data availability:* indicators should be available on a local or regional scale, being on city, NUTS 3 or NUTS 2 level. Moreover, data should be available for most of the cities, with the aim to reduce missing values and increase the reliability of the results.

2) *Ability to represent theoretical concepts:* indicators should well represent the favourable factors for sustainability experimentation. For each factor, several indicators were reviewed. Eventually, indicators were selected that reflected the factors the best.
3) *Originality*: each indicator should be different from the other indicators to avoid any overlap in measurement and to be able to discriminate between habitats.

An overview of the habitat-specific indicators is presented in Fig. 4. All other indicators (harbour and additional indicators) do not necessarily belong to one specific habitat and are therefore not included in this figure. In total, 41 indicators were collected, which are made up of 50% city level data, 10% NUTS 3 data, 36% NUTS 2 data and 5% country-level data. The indicators consist of 18 habitat indicators, 18 harbour indicators, and 5 additional indicators. The indicators are presented below.

4.3.1. Science-based campus milieu

A science-based campus, like Silicon Valley, often has strong links to local universities (Van den Heiligenberg et al., 2018). In such milieux, universities occupy a central position in the regional network, which could make it attractive for firms to collaborate with them. Therefore, *(1) University-industry collaboration* is used as a proxy for science-based campus milieu. A second measure for science-based campus milieu is the *(2) Average number of universities per capita* according to the Leiden Ranking 2018. This indicator represents the density of universities in a given city-region. Assuming that universities are part of a campus milieu, it thus reflects the density of a campus milieu.

4.3.2. Technological specialisation

The main argument behind technological specialisation is that geographical clusters and agglomeration economies, such as access to a pool of skilled employees, supporting intermediary organisations, and research institutes and universities, support the development of sustainability innovations (Hansen and Coenen, 2015). It is assumed that in a region characterised by technological specialisation, employment in high-tech sectors is higher than in regions with less technology-based industries. Hence, technological specialisation is measured by *(3) Employment in high-tech sectors*. Furthermore, Miguélez and Moreno (2013) use patent data from 30 technological sectors to measure technological specialisation. In general, patents and R&D intensity may provide an indication for a region's specialisation in high-tech. Therefore, *(4) High-tech patent application*, *(5) ICT patent applications*, *(6) Community design (CD) applications* and *(7) R&D intensity* are also used as indicators for technological specialisation.

4.3.3. Skilled labour

Rodríguez-Pose and Crescenzi (2008) showed that tertiary education and the rate of involvement in life-long learning are important factors in explaining the innovative performance of regions. In general, knowledge created in universities is fundamental for the development of skills and expertise which are needed in a region (Sleuwaegen and Boiardi, 2014). As a result, this factor is measured by *(8) Tertiary education* and *(9) Lifelong learning*.

4.3.4. Counterculture

Longhurst (2013) developed a typology of countercultures consisting of the following dimensions: (a) radical formal politics, (b) new social movements, (c) alternative pathways, (d) alternative spiritualities and (e) alternative lifestyles. Longhurst (2015) defines alternative lifestyles as non-conventional

lifestyles that are chosen specifically as an alternative to mainstream lifestyles. This includes, among others, people living in intentional communities (e.g. ecovillages, cohousing, cooperative houses and communes). Therefore, *(10) Intentional communities* are used as a proxy for counterculture. Furthermore, Longhurst (2013) also described that counterculture is characterised by subcultures, including the hipster community. The hipster culture could be seen as part of counterculture through their adoption of styles that oppose mainstream consumerism (Hubbard, 2016). Thus, *(11) Hipster culture* is used as a second proxy for counterculture. This variable is derived from the Hipster Index. Additionally, Longhurst (2013; 2015) described how the presence of counterculture in Totnes (UK) supported the launch of the Transition Town movement. The alternative milieu provided space to radical ideas and unconventional belief systems which proved to be favourable conditions for sustainability experimentation. It is assumed that a transition town could also indicate the presence of counterculture. Therefore, this study incorporates *(12) Transition town initiatives* – grassroots community-initiatives of social innovation – as an indicator for counterculture. Transition town initiatives may also indicate the presence of food sharing initiatives. Lastly, *(13) Community action* is used to capture the presence of groups that seek radical change in existing political systems. This indicator reflects the percentage of people that belong to local community action groups on issues like poverty, employment, housing and racial equality.

4.3.5. Creativity

Both Cohendet et al. (2010) and Florida (2002b) linked the degree of innovativeness within a region to the local concentration of creative people, in fields such as arts, theatre, multimedia etc. More specifically, Håkansson (2019) found a highly significant correlation between people working in creative industries and the existence of food-growing projects. This suggests a close link between creativity and urban food initiatives. Hence, creativity is measured by *(14) Jobs in creative sectors*. Moreover, creativity is measured by *(15) UNESCO Creative Cities Network member*, as members of the network have identified creativity and cultural industries as their strategic factor for sustainable development.

4.3.6. Makerspaces

Makerspaces foster grassroots experimentation, invention, and creation through design thinking and project-based learning (Institute of Museum and Library Services, 2012). They are spaces where regional knowledge and skills come together. Makerspaces include, among others, fabrication labs (fab labs), hackerspaces and repair cafés. Therefore, this factor is measured by examining the amount of *(16) Makerspaces* per city-region.

4.3.7. Cooperative culture

This factor is measured by *(17) Coworking spaces*. According to Capdevila (2018), coworking spaces enable cooperation, knowledge sharing and mutual learning. They allow people with different backgrounds to meet in an informal way and exchange ideas which can stimulate the creation of new innovations. Coworking spaces seem relevant for people involved in grassroots experiments, as they support strong community-building (Capdevila, 2018). Richardson (2017) describes that the growth of the digital sharing economy (of which food sharing is part) has resulted in an increasing demand for suitable and affordable office space. As a result, coworking spaces have become more important. They may play a vital role in helping citizens involved in grassroots experiments and food sharing start-ups grow by offering shared workspace and fostering business growth (Richardson, 2017). Moreover, *(18)*

Inter-firm collaboration represents the second indicator of cooperative culture and measures the proportion of innovative SMEs collaborating with others.

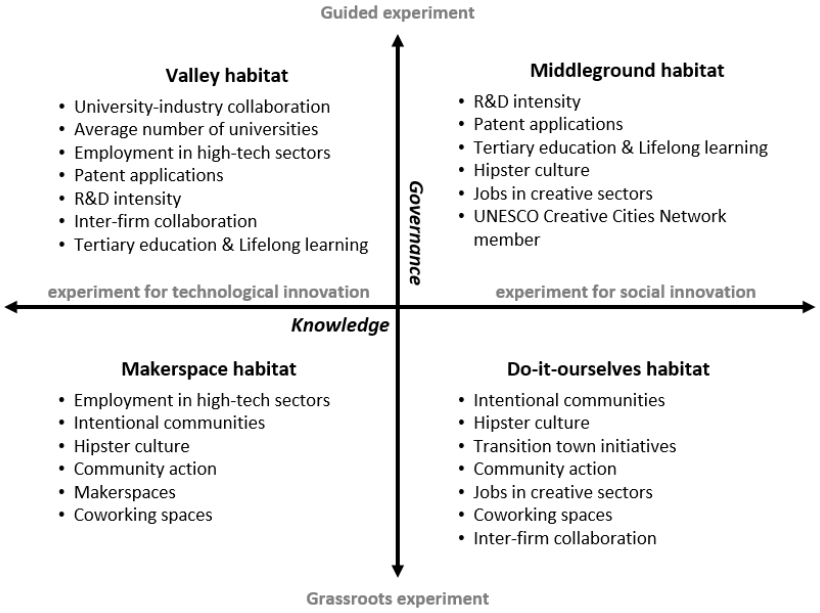


Fig. 4. Overview of habitat-specific indicators.

4.3.8. Place-reputation

Cities are increasingly being framed as green, sustainable, digital, low-carbon and so on (de Jong et al., 2015). Such place-reputations may enhance a city's attractiveness and encourage competition and cooperation with other cities (Torrens et al., 2018a). Therefore, place-reputation is measured through three representative indices: *(19) Sustainable Cities Index*, *(20) Cities in Motion Index and (21) Smart Cities Index*. The *Sustainable Cities Index* from Arcadis measures the sustainability of cities based on the three pillars of sustainability: people, planet and profit. The first pillar measures social performance including quality of life. The second pillar measures energy, pollution and emissions. The third pillar assesses business environment and economic health. The *Cities in Motion Index* measures the following twelve dimensions: human capital, social cohesion, economy, public management, governance, environment, mobility and transportation, urban planning, international outreach, technology, city cluster and country cluster. The *Smart City Index* measures the following seven dimensions of a smart city: transport and mobility, sustainability, governance, innovation economy, digitalisation, living standard and expert perception.

Considering the close link between food sharing and (environmental) sustainability, the indicators *(22) Regional green economic performance* and *(23) Green urban areas and forests* are included to reflect the 'greenness' of cities.

4.3.9. Reputation of powerful local actors

Torrens et al. (2018a) mentioned that the reputation of leading universities is crucial for attracting talent within a region. This is also supported by a large number of studies – especially in the field of economic geography – which describe how the presence of a university can stimulate a region's innovation potential (Sleuwaegen and Boiardi, 2014). Therefore, *(24) University ranking* is used to measure the reputation of powerful local actors.

4.3.10. Openness, tolerance and trust

It is assumed that cities which are characterised by a high number of foreign people are more open and tolerant of other cultures, religions, ideas and so on. Similar to Florida (2002a), intercultural openness is measured by *(25) Foreign-born population*. Moreover, the research incorporates *(26) Tolerance of foreigners*, *(27) Integration of foreigners* and *(28) Human Rights* as measures of intercultural openness. S&T openness is measured by *(29) International co-publications*. Furthermore, the literature argues that a sense of interpersonal trust reinforces cooperation. For example, interpersonal trust allows the creation of strong-tie networks and supports the diffusion of knowledge spillovers and tacit knowledge (Sleuwaegen and Boiardi, 2014). Also, Asheim and Gertler (2006) emphasised the importance of trust-based relations in the cooperation between firms and customers in regional clusters. It is expected that trust in society is a prerequisite for learning in local and regional sustainability networks. Hence, *(30) Interpersonal trust* is used as an indicator of openness, tolerance and trust.

4.3.11. Transnational municipal networks

This factor is measured by *(31) Membership of transnational municipal networks*, including ICLEI, C40, EUROCITIES, UNESCO Creative Cities Network and Sharing Cities Network. These networks are often mentioned to be important for the diffusion of sustainability experiments (Blok, 2012; Williams, 2017). While these networks all focus on sustainable development, the Sharing Cities Network also includes food sharing.

4.3.12. International meetings

Especially for grassroots innovations, the exchange of tacit knowledge through face-to-face interaction proved to be a crucial factor for the diffusion of ideas and experiences (Feola and Butt, 2017). According to Cohendet et al. (2010) events such as festivals, business fairs and conferences confront places with knowledge and practices from different parts of the world. Therefore, *(32) International meetings* are a suitable proxy for this factor. A second measure is *(33) International cultural festivals.* Cultural festivals are often community-based with, for example, food or music acting as a social agent that brings people with different ages, professions and cultural backgrounds together (Rut and Davies, 2018). Such gatherings support the exchange of tacit knowledge and could initiate new community-based initiatives.

4.3.13. Funding

As part of capital-related transnational linkages, Wieczorek et al. (2015) mentioned venture capital and grants from development banks and other institutions to be important enablers of sustainability experiments. Funding, especially foreign investments, may generate technology spillovers and raise environmental efficiency. This may support the diffusion of food sharing experiments. Therefore, the first proxy for funding is the *(34) Availability of venture capital*. Furthermore, since grassroots innovations can be seen as niches which operate outside the mainstream market, they mostly rely on external funding (e.g. grants, donations, sponsorships and fundraising events) from local authorities, banks, foundations or private organisations (Feola and Nunes, 2014; Seyfang and Smith, 2007). This type of funding is reflected by the *(35) Availability of funds from the public sector* and *(36) Structural funds dedicated to entrepreneurship and SMEs.*

4.3.14. Quality of government

Quality of government is measured by the *(39) European Quality of Government Index (EQI)*. This index was developed by the Quality of Government Institute of Gothenburg University and is the only measure of institutional quality available at the regional level in the European Union (European Commission, 2018). Additionally, an index was compiled based on the six pillars of the *(40) Worldwide Governance Indicators (WGI)*, developed by the World Bank. While the WGI index is on country-level, it is used as an indicator for the quality of government of city-regions not covered by the EQI, including Zurich, Istanbul and Moscow. Additionally, this factor is measured by *(41) Poverty and social inclusion*. It is assumed that city-regions characterised by a high degree of poverty and social exclusion have a low density of urban food sharing experiments. This might be caused by their limited access to and knowledge from ICT, which is required for the food sharing experiments under study (Edwards and Davies, 2018).

4.3.15. Economic well-being

It is expected that cities with a higher GDP have more resources available for sustainability experimentation. As a result, *(38) GDP* is included as an indicator of economic well-being.

4.3.16. Internet penetration rate

ICT-mediated food sharing experiments require internet access to operate properly. Davies et al. (2017b) note that internet access may play a role in providing a supporting infrastructure which allows urban food sharing to develop more easily. Therefore, it is expected that cities of which a higher proportion of the population is connected to the internet, are better able to facilitate urban food sharing experiments. Hence, *(37) Availability and accessibility of internet connections* is used as a proxy of internet penetration rate.

4.4. Data analysis

Appendix E shows the descriptive statistics of the variables used in the analysis. Due to the low number of cases (29), multiple regression analysis was not appropriate. Instead, a more explorative approach was used to identify patterns in the data. This approach consisted of rankings and correlations. First, the top five best and worst-performing cities of each indicator were highlighted to better understand the differences between cities. This resulted in an overview of all 29 cities with their corresponding number of indicators in the top five best performance (see Appendix F). Second, Pearson correlations (see Appendix G) were calculated to identify which indicators significantly influenced the number of food sharing experiments per capita. Pearson correlations were also used to discuss the relationship between variables that related to the same theoretical concept or which were expected to be closely linked.

4.5. Research quality

To increase validity, a time lag was included between the dependent and independent variables. Because the SHARECITY100 Database included experiments collected in 2016, independent variables were collected up to and including 2016. However, this was not possible for all variables, as some databases were updated frequently and did not provide historical data.

The method used to collect food sharing initiatives for the SHARECITY100 database, as described in Section 4.1, warrants a complete picture of all food sharing initiatives worldwide at the time data were collected. While it cannot be guaranteed that no initiatives have been missed, SHARECITY strives for completeness; they welcome any feedback or suggestions for updates and aim to revise the database twice a year until 2020 (SHARECITY, 2016).

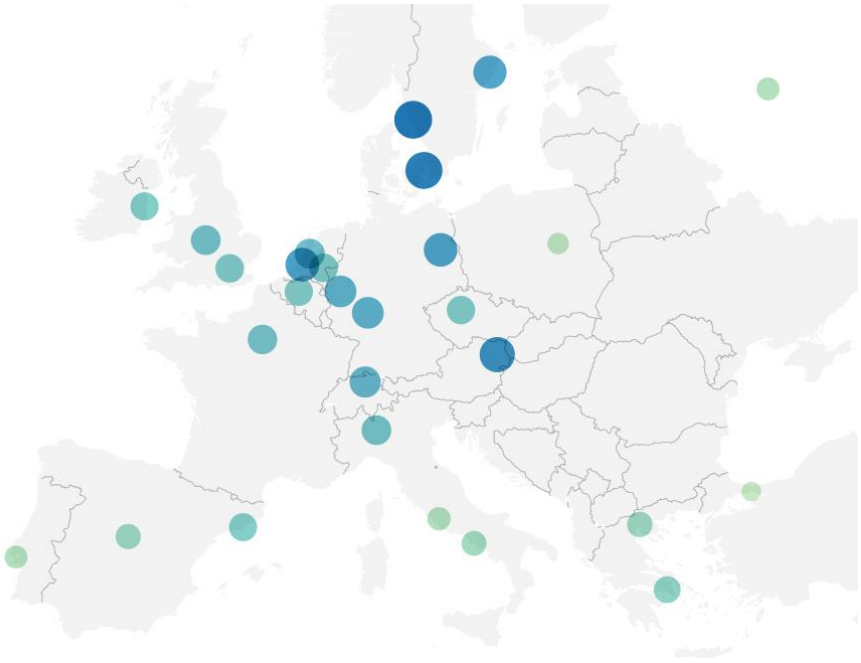
5. Results

This section starts by outlining the results of the indicators that significantly correlated with the dependent variable. These indicators were used to test the mechanisms in the conceptual model. It then discusses the implications of these findings for the conceptual model and critically reviews the adequacy of the conceptual model. Lastly, the section discusses the limitations of the indicators that were used in the analysis.

5.1. Results per indicator

For each of the indicators that were found to correlate significantly with the dependent variable, performance is displayed in geographical maps and a ranking is provided. Significant correlations were found for seven habitat indicators, seven harbour indicators and two of the additional indicators. While some maps were already available, others were created using Datawrapper. The size and intensity of the blue circles on these maps correspond with the city's performance; thus the bigger the circle, the higher its performance.

University-industry collaboration



Rank	City
1	Gothenburg
2	Copenhagen
3	Vienna
4	Rotterdam
5	Berlin
6	Stockholm
7	Cologne
8	Frankfurt am Main
9	Zurich
10	Amsterdam
11	Birmingham
12	Milan
13	Paris
14	Nijmegen
15	London
16	Prague
17	Brussels
18	Dublin
19	Barcelona
20	Athens
21	Thessalonica
22	Madrid
23	Naples
24	Rome
25	Lisbon
26	Moscow
27	Warsaw
28	Istanbul
29	Bucharest

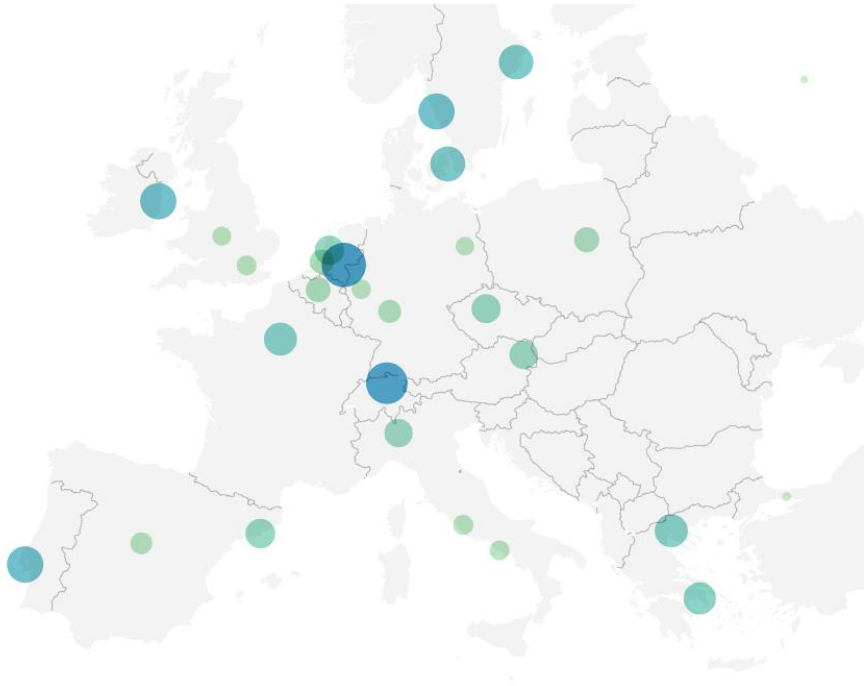
In Gothenburg, Chalmers University of Technology ranks 4th of Europe on university-industry collaboration with a proportion of 12,5% of all its publications co-authored with one or more industrial partners. Together with the University of Gothenburg (7,9%), Gothenburg performs best of all 29 cities in terms of university-industry collaboration. Bucharest ranks lowest because none of its universities is listed in the Leiden Ranking. To compare, the second-worst city, Istanbul, has an average proportion of 2,4% of its publications co-authored with one or more industrial partners.

University-industry collaboration positively correlates with *technological specialisation* and *skilled labour* indicators, including *High-tech patent applications (0,476**)*, *ICT patent applications (0,486**)*, *CD applications (0,468**), R&D intensity (0,719*)* and *Lifelong learning (0,687**).* This

strongly suggests the presence of technology hubs in certain cities. For example, Berlin, Copenhagen, Gothenburg and Stockholm all rank at the top five of several of these indicators.

Based on the conceptual model, no relationship was expected between food sharing experiments and a science-based campus milieu. According to the model, a science-based campus milieu is places characterised by technological experiments rather than experiments for social innovation.

Universities per capita



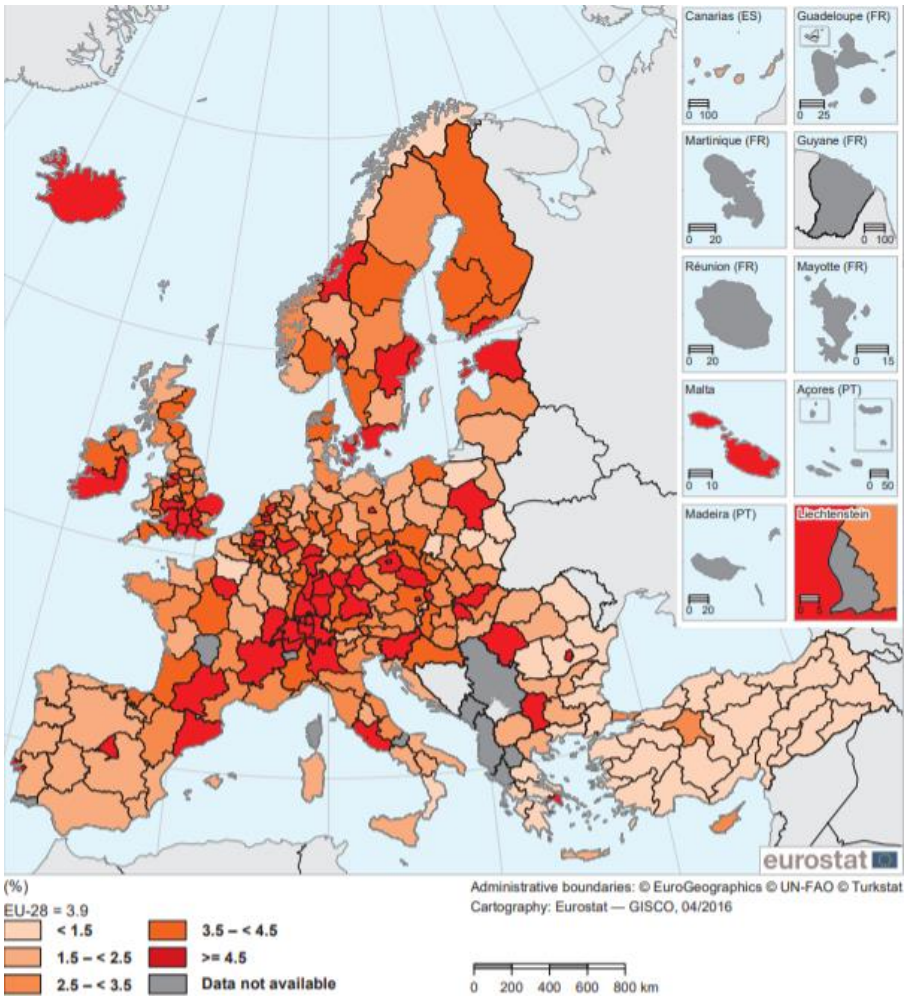
Rank	City
1	Nijmegen
2	Zurich
3	Lisbon
4	Dublin
5	Gothenburg
6	Copenhagen
7	Stockholm
8	Thessalonica
9	Paris
10	Athens
11	Barcelona
12	Amsterdam
13	Prague
14	Vienna
15	Milan
16	Warsaw
17	Brussels
18	Rotterdam
19	Frankfurt am Main
20	Madrid
21	Rome
22	London
23	Naples
24	Cologne
25	Birmingham
26	Berlin
27	Istanbul
28	Moscow
29	Bucharest

The average number of universities per city inhabitant correlates positively with the number of experiments per 100,000 city inhabitants. Underlying mechanisms for this positive influence of a university might include the following: raising awareness about the environment and sustainability through education and scientific publications, attracting talent and creative people, and facilitating codified and tacit knowledge exchange among students and teachers.

While cities with a high average number of universities per capita are characterised by a high number of food sharing initiatives per capita, cities with a low number of universities per capita are also characterised by a low number of food sharing initiatives per capita.

Universities per capita positively correlates with the other science-based campus milieu indicator *University-industry collaboration (0,392*)*. Similar to *University-industry collaboration*, no relationship was expected between food sharing experiments and the density of universities in the area. However, a possible reason for the significant relationship could be related to the role of universities in sustainability experimentation. Voytenko et al. (2016) noted that university campuses play a central role in designing and setting up ULLs for low carbon cities, which in turn could be explained by the fact that they received large amounts of funding from the European Commission to initiate these ULLs. While Van den Heiligenberg et al. (2018) found that experiments for technological innovation often have strong links with the universities in the area, it could also be that these universities produce knowledge and organise events (e.g. symposia) which might be valuable to those who participate in urban food sharing experiments.

Employment in high-tech sectors



Rank	City
1	Dublin
2	Prague
3	Madrid
4	Warsaw
5	Stockholm
6	Bucharest
7	London
8	Berlin
9	Paris
10	Zurich
11	Rome
12	Vienna
13	Brussels
14	Copenhagen
15	Lisbon
16	Moscow
17	Athens
18	Cologne
19	Milan
20	Barcelona
21	Rotterdam
22	Gothenburg
23	Birmingham
24	Nijmegen
25	Frankfurt am Main
26	Amsterdam
27	Istanbul
28	Naples
29	Thessalonica

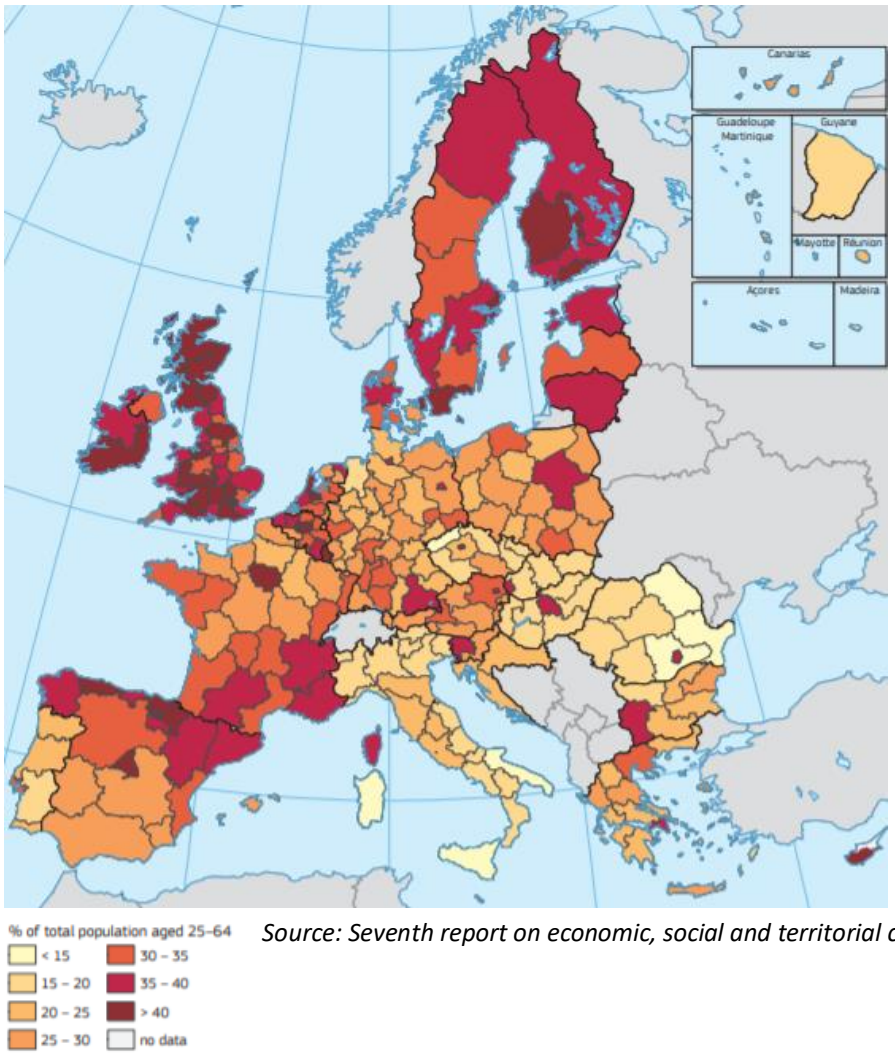
Source: Eurostat regional yearbook 2016.

The share of total employment in high-tech sectors is especially high in capital regions, regions close to capitals, Switzerland and Southern Germany (Baden-Württemberg and Bavaria). Southern Germany and Switzerland are indeed famous for their technology-oriented focus and innovation capacity.

Employment in high-tech sectors positively correlates with *Tertiary education (0,623**).* This may be due to a bias in the measurement of high-tech sectors. High-tech sectors are composed of high-technology manufacturing and high-technology knowledge-intensive services (Eurostat, 2018a). Focussing on the latter, an activity is classified as knowledge-intensive if the employment of persons with tertiary education attainment represents more than a third of the total employment in that activity (Eurostat, 2018b). Another explanation could be that high-tech jobs simply require more complex skills and expertise that only people with higher education attainment possess.

According to the conceptual model, no relationship was expected between food sharing experiments and technological specialisation. Yet, Berlin, Copenhagen, Frankfurt, Vienna and Zurich show a strong specialisation in technology, while at the same time all of them rank in the top five in terms of food sharing experiments per capita. A possible explanation could be that these are large city-regions hosting multiple favourable habitats at a time, so habitats for technological innovation experiments as well as habitats for social innovation experiments.

Population aged 25-64 years with tertiary education attainment



Rank	City
1	London
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13	Vienna
14	Berlin
15	Barcelona
16	Moscow
17	Athens
18	Rotterdam
19	Birmingham
20	Bucharest
21	Nijmegen
22	Cologne
23	Frankfurt am Main
24	Lisbon
25	Thessalonica
26	Rome
27	Istanbul
28	Milan
29	Naples

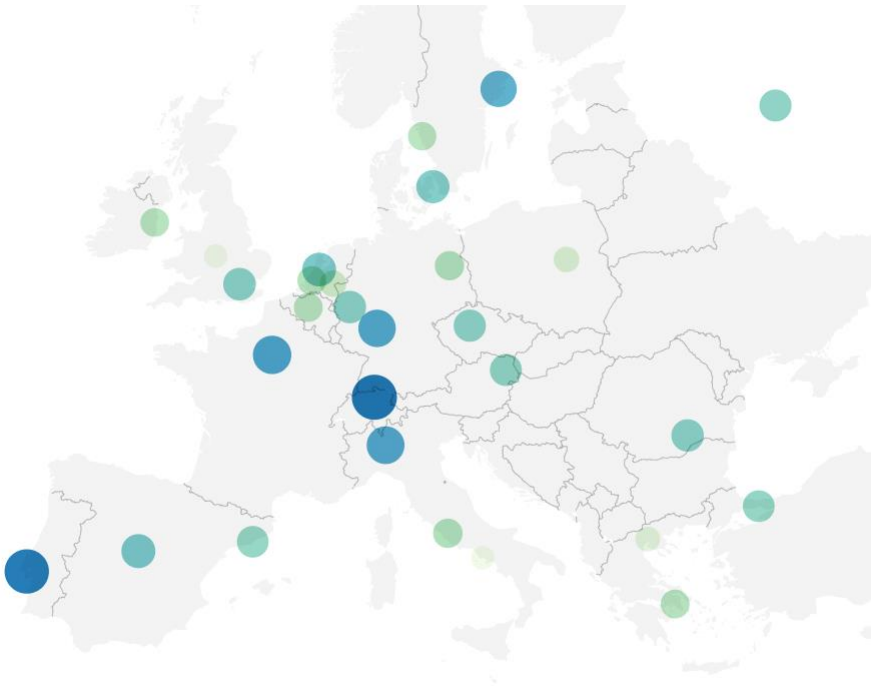
Source: Seventh report on economic, social and territorial cohesion.

Tertiary education attainment is highly distributed within EU countries. In many countries, performance is higher in capital cities. The largest contrast is observed in Romania, where Bucharest performs far better than the rest of Romania. Similar patterns are observed in Portugal, Spain, France, Germany, Austria and Poland. In general, Italy and Romania perform considerably worse than the rest of Europe.

Tertiary education positively correlates with *Lifelong learning (0,468**)*, another indicator for a skilled workforce. Copenhagen, Stockholm and Zurich are in the top five of both tertiary education and lifelong learning. Furthermore, tertiary education positively correlates with several technology and innovation indicators, i.e. *Employment in high-tech sectors (0,623**)*, *High-tech patent applications (0,459*)*, *ICT patent applications (0,436*)* and *CD applications (0,480**)*. This supports the findings of Rodríguez-Pose and Crescenzi (2008) that the presence of skilled labour is linked to the innovative performance of a region.

In line with the conceptual model, a relationship was expected between the dependent variable and *Tertiary education*. The significant association between the dependent variable and *Tertiary education* suggests that skilled labour is indeed an important context factor facilitating guided experiments for social innovation. This is in line with Van den Heiligenberg et al. (2018), who found that the education levels and presence of knowledge institutes are particularly important in the upper quadrants of the model.

Jobs in creative sectors



Rank	City
1	Zurich
2	Lisbon
3	Paris
4	Milan
5	Frankfurt am Main
6	Stockholm
7	Madrid
8	Amsterdam
9	Copenhagen
10	London
11	Cologne
12	Bucharest
13	Prague
14	Moscow
15	Vienna
16	Istanbul
17	Barcelona
18	Rome
19	Berlin
20	Brussels
21	Athens
22	Rotterdam
23	Dublin
24	Gothenburg
25	Nijmegen
26	Warsaw
27	Thessalonica
28	Birmingham
29	Naples

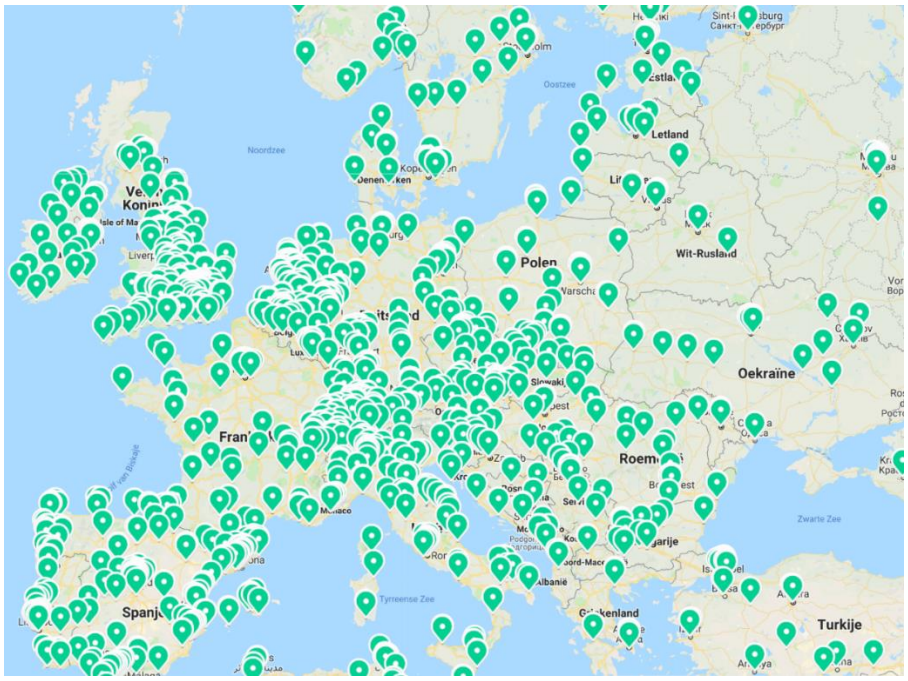
What stands out is the fact that Frankfurt is in the top five best performance of creative employment, but ranks at the bottom of high-tech employment. The contrary is observed in Warsaw, which ranks third in terms of high-tech employment, but is among the worst-performing city-regions in terms of creative employment. These results support the idea that regions specialise in certain industries.

Jobs in creative sectors positively correlates with *High-tech patent applications (0,408*)* and *Hipster culture (0,693**).* A reason for the correlation with *High-tech patent applications* could be that a region's capacity to innovate (measured by patents) strongly links to its ability to attract talented and creative people (measured by creative class employment). In his work, Richard Florida has paid considerable attention to this relationship. The strong correlation with *Hipster culture* supports the link between hipsters and 'creatives' as described by Florida (2002b).

Interestingly, Lisbon ranks second in terms of creative employment and fifth in terms of international cultural festivals. Moreover, Prague is the only city within the sample which is a member of the UNESCO Creative Cities Network and hosts the third most cultural festivals.

The significant correlation between the dependent variable and *Jobs in creative sectors* supports earlier findings that creativity is a favourable context factor for guided experiments for social innovation. However, as noted by Van den Heiligenberg et al. (2018), creativity is also important for the other habitats, including the habitat favourable for grassroots experiments for social innovation.

Coworking spaces



Source: Coworker.com.

Rank	City
1	Lisbon
2	Amsterdam
3	Zurich
4	Barcelona
5	Copenhagen
6	Rotterdam
7	Dublin
8	Stockholm
9	Paris
10	Frankfurt am Main
11	Madrid
12	Milan
13	Brussels
14	Vienna
15	London
16	Berlin
17	Athens
18	Prague
19	Warsaw
20	Gothenburg
21	Cologne
22	Thessalonica
23	Bucharest
24	Birmingham
25	Nijmegen
26	Rome
27	Istanbul
28	Moscow
29	Naples

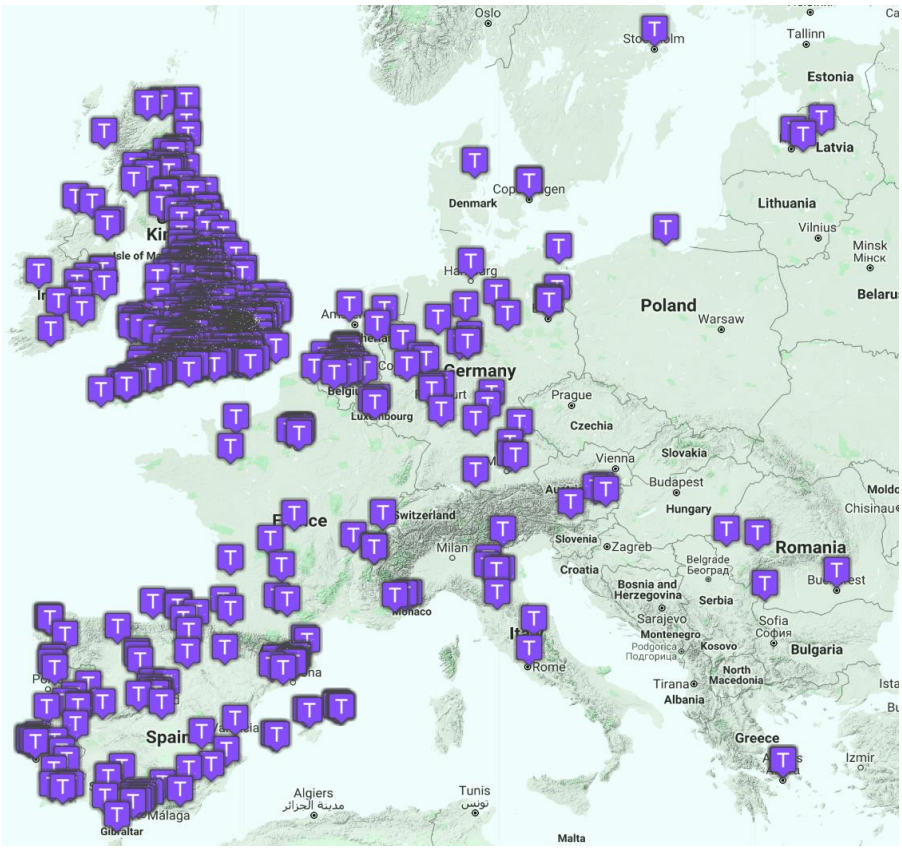
While the figure above shows the spatial distribution of the absolute number of coworking spaces in Europe, this distribution maintains relatively stable when denominating the number of coworking spaces by the city population.

Coworking spaces positively correlates with *Hipster culture (0,597*), Jobs in creative sectors (0,676**), Makerspaces (0,563**)* and *International meetings (0,802**)*. These relationships can be explained in several ways. First, coworking spaces, makerspaces and international meetings are all ways for people to interact and exchange tacit knowledge on a local scale; they facilitate networking. Second, coworkers and 'makers' can both be considered part of the 'knowing community'. A knowledge community can be defined as a group of "members working in close proximity to one another, in which identity formation through participation and the negotiation of meaning are central to learning and knowledge generation" (Amin and Roberts, 2008, p. 355). Third, Brown (2017) discusses the coherence between coworking and creative industries and, among others, describes the role of coworking spaces in attracting creative professionals. Lastly, the mutual relationship between hipsters and makers can be explained by the fact that both are community-based lifestyles of mostly young adults who share the same ideology and interest in DIY creative pursuits (Wasielewski, 2018).

No correlation was measured between coworking spaces and the other cooperative culture indicator *Interfirm collaboration*.

According to the conceptual model, a relationship was expected between the dependent variable and a cooperative culture. Based on the significant correlation with *Coworking spaces*, the analysis suggests that a cooperative culture is indeed a favourable context factor facilitating grassroots experiments for social innovation. Thereby, it supports findings from Truffer and Coenen (2012) that cooperation cultures are beneficial for grassroots initiatives. Moreover, since food sharing is essentially a fundamental form of cooperation (Jaeggi and Gurven, 2013), a cooperative culture seems an inevitable requirement for the emergence of food sharing experiments.

Transition town initiatives



Rank	City
1	London
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3	Frankfurt am Main
4	Lisbon
5	Copenhagen
6	Brussels
7	Barcelona
8	Dublin
9	Nijmegen
10	Madrid
11	Birmingham
12	Berlin
13	Rotterdam
14	Bucharest
15	Stockholm
16	Athens
17	Rome
18	Amsterdam
19	Cologne
20	Gothenburg
21	Istanbul
22	Milan
23	Moscow
24	Naples
25	Prague
26	Thessalonica
27	Vienna
28	Warsaw
29	Naples

Source: Ecolise.

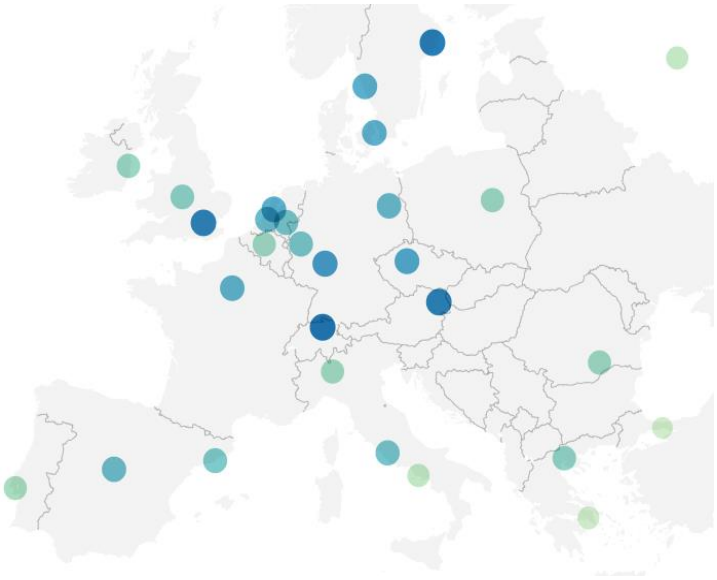
While the figure above presents the spatial distribution of the absolute number of transition towns, it shows the strong clustering of transition towns in EU regions. The strong clustering in the UK can be explained by the fact that the transition movement started in Totnes, UK. From there, the movement rapidly spread to neighbouring towns and eventually to other countries in Europe.

Many city-regions, including Amsterdam, Cologne, Gothenburg, Istanbul, Milan, Naples and more, do not host any transition town initiative in their city areas. This corresponds with the notion that transition town initiatives are mainly located in small market towns (Longhurst, 2013).

No correlations were measured between *Transition town initiatives* and the other counterculture indicators *Intentional communities*, *Hipster culture*, and *Community action*.

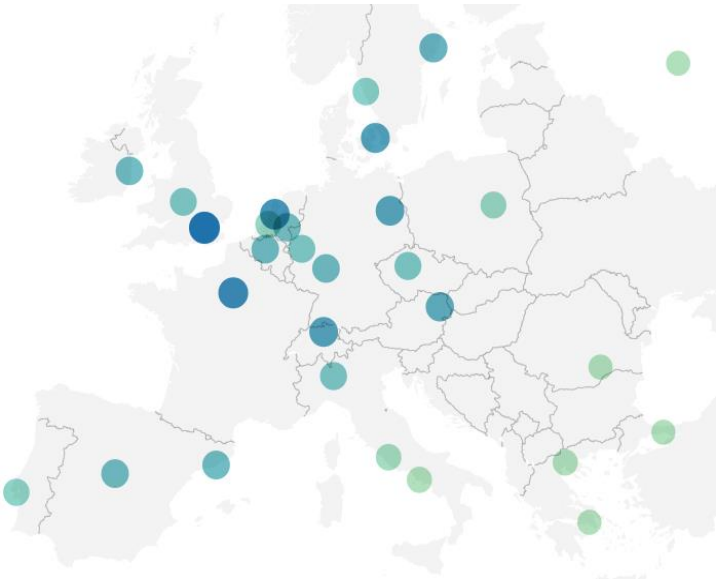
The relationship between the dependent variable and *Transition town initiatives* confirms the expectation that urban food sharing experiments are located in city-regions characterised by the presence of an alternative milieu or counterculture (Longhurst, 2015). In line with Van den Heiligenberg et al. (2018), it indicates that counterculture is an important localised informal institution for sustainability experiments.

Sustainable Cities Index



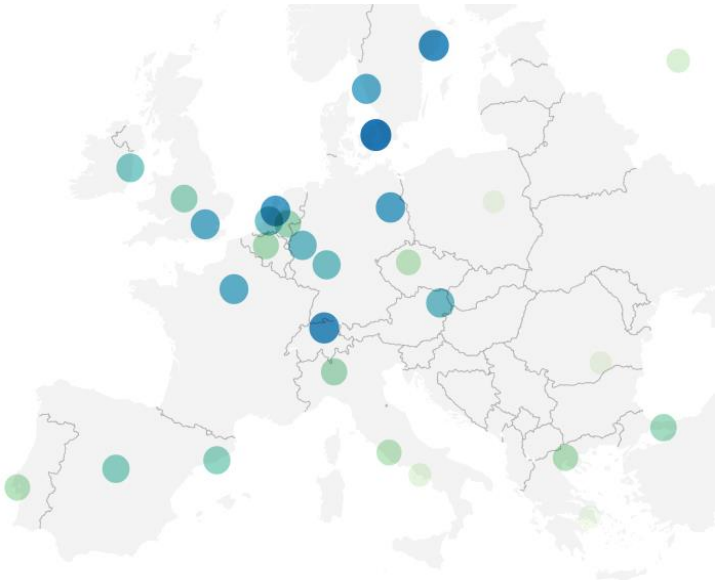
Rank	City		
1	Zurich	16	Cologne
2	Stockholm	17	Barcelona
3	Vienna	18	Birmingham
4	London	19	Thessalonica
5	Frankfurt am Main	20	Dublin
6	Prague	21	Warsaw
7	Amsterdam	22	Brussels
8	Gothenburg	23	Bucharest
9	Copenhagen	24	Milan
10	Paris	25	Lisbon
11	Berlin	26	Naples
12	Rotterdam	27	Moscow
13	Madrid	28	Athens
14	Nijmegen	29	Istanbul
15	Rome		

Cities in Motion Index



Rank	City		
1	London	16	Prague
2	Paris	17	Birmingham
3	Amsterdam	18	Cologne
4	Copenhagen	19	Gothenburg
5	Zurich	20	Lisbon
6	Berlin	21	Rotterdam
7	Vienna	22	Warsaw
8	Stockholm	23	Rome
9	Brussels	24	Naples
10	Barcelona	25	Thessalonica
11	Madrid	26	Moscow
12	Frankfurt am Main	27	Istanbul
13	Dublin	28	Bucharest
14	Nijmegen	29	Athens
15	Milan		

Smart City Index



Rank	City		
1	Copenhagen	16	Birmingham
2	Stockholm	17	Istanbul
3	Zurich	18	Nijmegen
4	Amsterdam	19	Milan
5	Berlin	20	Brussels
6	Gothenburg	21	Lisbon
7	London	22	Thessalonica
8	Paris	23	Rome
9	Cologne	24	Prague
10	Vienna	25	Moscow
11	Rotterdam	26	Naples
12	Frankfurt am Main	27	Bucharest
13	Dublin	28	Warsaw
14	Madrid	29	Athens
15	Barcelona		

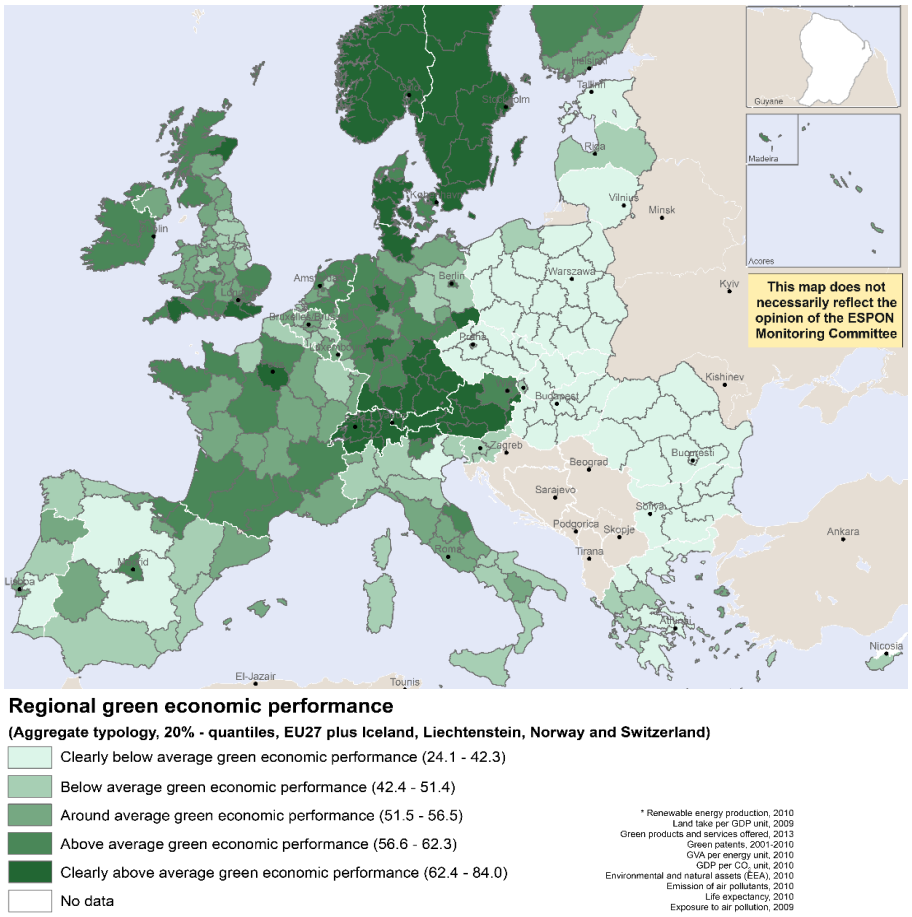
The Sustainable Cities Index positively correlates with *University-industry collaboration (0,490**), High-tech patent applications (0,519**), ICT patent applications (0,527**), CD applications (0,387*), Tertiary education (0,435*), Lifelong learning (0,507**), Tolerance of foreigners (0,421*), Human rights (0,405*), Interpersonal trust (0,457*), Internet access (0,447*)* and *WGI Index (0,714**)*. What stands out is that this indicator mainly correlates with technological specialisation, skilled labour and openness indicators. The correlation with Tertiary education can be explained by the fact that this indicator is included in the Sustainable Cities Index. Furthermore, the Sustainable Cities Index positively correlates with the other place-reputation indicator *Cities in Motion Index (0,687**)*, which also measures liveability and citizen well-being.

Similar to the Sustainable Cities Index, the Cities in Motion Index positively correlates with *University-industry collaboration (0,541**), High-tech patent applications (0,485**), ICT patent applications (0,440*), CD applications (0,548*), Tertiary education (0,579*), Lifelong learning (0,462*), Tolerance of foreigners (0,424*), Human Rights (0,642**), Interpersonal trust (0,492**), Internet access (0,405*)* and *WGI Index (0,668**)*. Other correlations include *Transition Town initiatives (0,519**), Makerspaces (0,570**), University rank (0,676**), GDP (0,515**)* and *EQI (0,515*)*. Furthermore, the Cities in Motion Index positively correlates with the other place-reputation indicator Smart City Index (0,738**). The correlation with Tertiary education, EQI and WGI Index can be explained by the fact that these indicators are also included in the Cities in Motion Index.

Similar to both the Sustainable Cities Index and Cities in Motion Index, the Smart City Index positively correlates with *University-industry collaboration (0,697**), High-tech patent applications (0,615**), ICT patent applications (0,603*), CD applications (0,426*), Tertiary education (0,383*), Lifelong learning (0,663**), Tolerance of foreigners (0,534**), Human Rights (0,537*), Interpersonal trust (0,614**), Internet access (0,576**)* and *WGI Index (0,675**).* Other correlations include *R&D intensity (0,514*), Makerspaces (0,481*), University ranking (0,417*), International co-publications (0,520**), EQI (0,687**)* and *Poverty and social exclusion (-0,486*).* Furthermore, the index positively correlates with the other place-reputation indicator *Green economic performance (0,512*).* The correlation with R&D intensity can be explained by the fact that R&D intensity is included in the Smart Cities Index.

What can be concluded from the strong relationship between the dependent variable and all three indices is that city-regions characterised by a high density of food sharing experiments have a place-reputation of being socially, environmentally and economically sustainable. In general, it indicates the presence of supportive ecosystems and governing structures for sustainability experimentation. Although it stays unclear to what extent a place-reputation can be regarded as a harbour factor which supports the diffusion of experiments, the findings stated above suggest that a city-region's place-reputation appears to be a favourable context factor for sustainability experimentation.

Regional Green Economic Performance



Rank	City
1	Berlin
2	Stockholm
3	Vienna
4	Brussels
5	Gothenburg
6	Amsterdam
7	Athens
8	Frankfurt am Main
9	Rotterdam
10	Copenhagen
11	Nijmegen
12	Madrid
13	Cologne
14	London
15	Zurich
16	Prague
17	Dublin
18	Istanbul
19	Lisbon
20	Paris
21	Barcelona
22	Thessalonica
23	Birmingham
24	Warsaw
25	Moscow
26	Milan
27	Rome
28	Bucharest
29	Naples

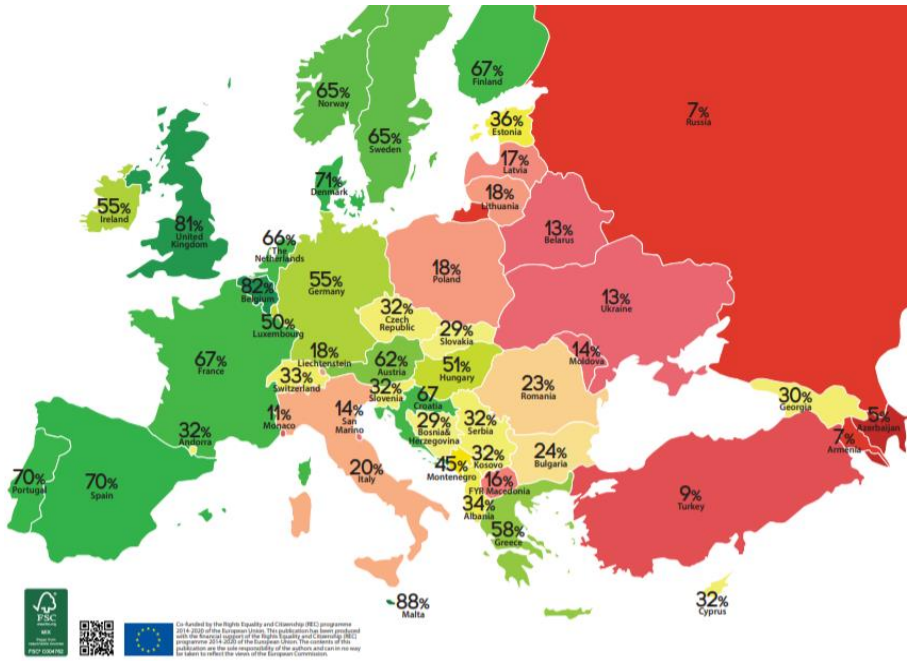
Source: ESPON.

Performance for Istanbul and Moscow is unknown. It stands out that all three cities in Italy are in the top five lowest performance. Indeed, these cities have one of the highest ozone, NO and PM10 concentrations (in µg/m³) of all 29 cities in Europe.

Regional green economic performance positively correlates with the place-reputation indicator *Green urban areas (0,426*)*. Regional green economic performance also positively correlates with the *EQI (0,549**)* and negatively correlates with *Poverty and social exclusion (-0,410*)*. An explanation for the correlation with green urban areas could be that cities with high green economic performance generally focus more on environmental sustainability. The correlation with the EQI may be due to the fact that the EQI 2009 has been used as an indicator to calculate green economic performance.

The significant association between the dependent variable and *Regional green economic performance* complements the findings from the three indices discussed above and supports the expectation that place-reputation is an important determinant in sustainability experimentation. However, it remains unclear if place-reputation also appears to be important for technological experiments.

Human Rights



Rank	City
1	Brussels
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4	Copenhagen
5	Barcelona
6	Lisbon
7	Madrid
8	Paris
9	Amsterdam
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11	Rotterdam
12	Gothenburg
13	Stockholm
14	Vienna
15	Athens
16	Thessalonica
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18	Cologne
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20	Frankfurt am Main
21	Zurich
22	Prague
23	Bucharest
24	Milan
25	Naples
26	Rome
27	Warsaw
28	Istanbul
29	Moscow

Source: ILGA-Europe.

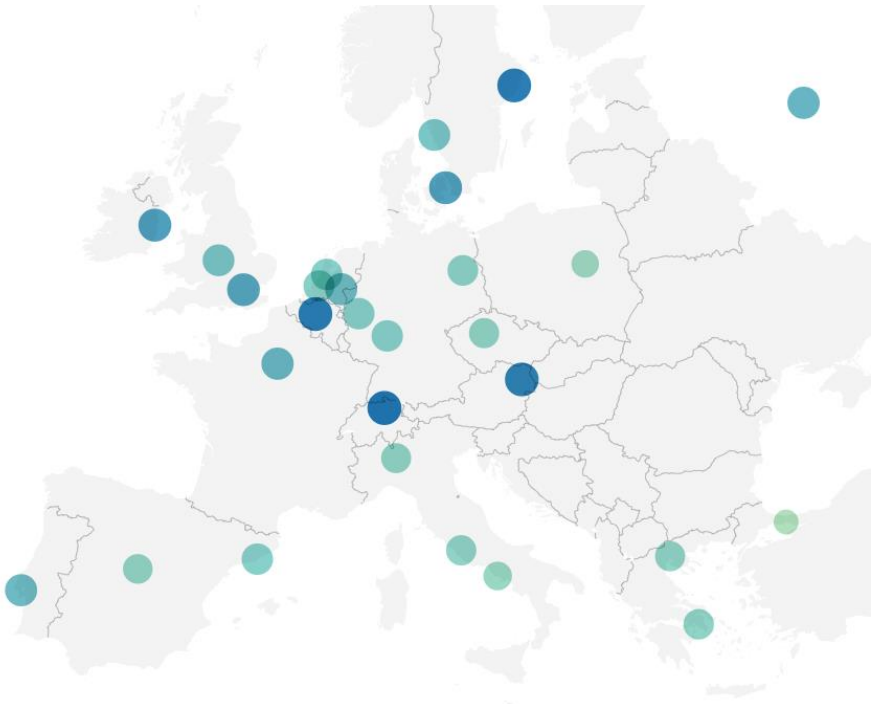
Overall, Eastern European countries have lower respect for human rights than Western European countries. For example, in Russia and Turkey, same-sex marriage is illegal and anti-discrimination laws concerning sexual orientation are lacking (Hutt, 2018). This indicates a lower openness towards people with a different sexual orientation and could indicate that these countries are less tolerant and open to other cultures in general.

No correlation was measured between Human rights and the other openness indicators *Foreign-born population*, *Tolerance of foreigners* and *Integration of foreigners* and *Interpersonal trust*. However, Human rights positively correlates with *International co-publications (0,562**)*. An explanation for this relation could be that researchers in regions characterised by a higher acceptance of human rights generally have more contact with foreign researchers and therefore have a higher chance of co-authoring their paper with researchers for other countries.

Results also suggest a link between human rights and the degree of cooperation in a region. Human rights positively correlates with the cooperative culture indicators *University-industry collaboration (0,560**), Inter-firm collaboration (0,433*)* and *Coworking spaces (0,468**)*. For example, Birmingham and Brussels rank first and third on inter-firm collaboration and have the highest respect for human rights; 81 and 82% respectively. Similarly, Moscow and Istanbul are ranked in the bottom five on coworking spaces and also have the lowest respect for human rights; 7 and 9% respectively. Naples even ranks in the bottom five on both inter-firm collaboration and coworking spaces and also performs badly on human rights (20%).

The findings support the assumption of the conceptual model that city-regions characterised by openness offer favourable environments for sustainability experimentation. Specifically, *Human rights* intended to reflect a culture of openness and open-mindedness, which has shown to be one of the most important factors enabling upscaling of sustainability initiatives (Van den Heiligenberg et al., 2018). Furthermore, results suggest that intercultural openness is an important requirement for other favourable context factors, mainly related to cooperation.

International co-publications



Rank	City
1	Zurich
2	Brussels
3	Stockholm
4	Vienna
5	Dublin
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7	London
8	Moscow
9	Paris
10	Lisbon
11	Nijmegen
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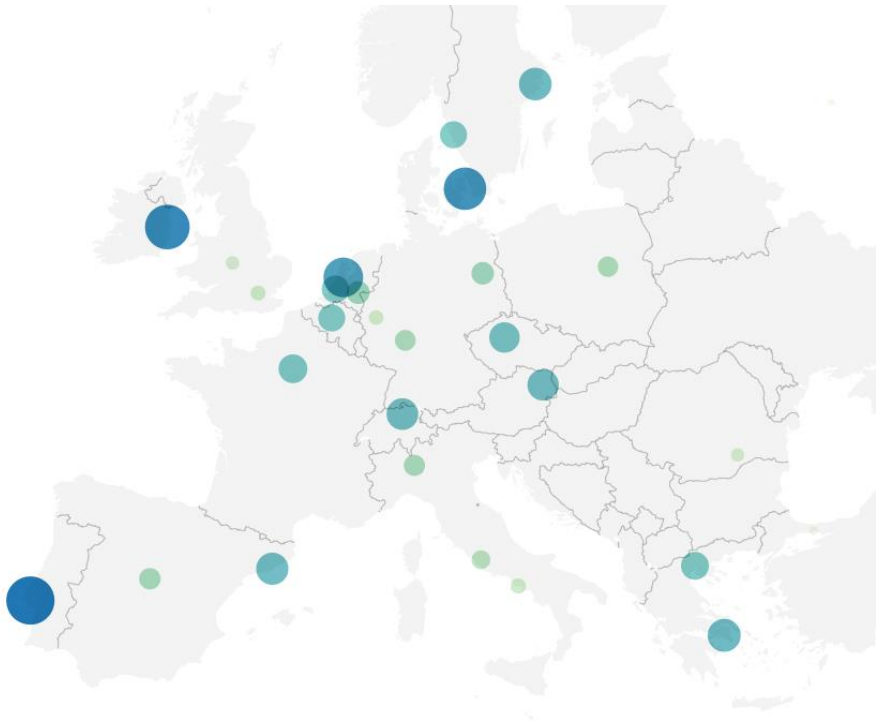
14	Cologne
15	Amsterdam
16	Frankfurt am Main
17	Barcelona
18	Rotterdam
19	Berlin
20	Athens
21	Rome
22	Prague
23	Thessalonica
24	Milan
25	Madrid
26	Naples
27	Warsaw
28	Istanbul
29	Bucharest

On the one hand, it stands out that Brussel ranks first in terms of international co-publications and also has the highest respect for human rights in Europe (82%). On the other hand, Istanbul, Naples and Warsaw all rank at the bottom five for both indicators.

International co-publications positively correlates with *University-industry collaboration (0,679**)*, *Universities per capita (0,491**)*, *High-tech patent applications (0,418*)*, *ICT patent applications (0,428*)* and *Human rights (0,562**)*. While international co-publications is used as an indicator for S&T openness, it can also be used as a proxy of knowledge production or scientific output. This could explain why international co-publications positively correlates with indicators referring to a science-based campus milieu and technological specialisation.

In contrast to *Human rights*, *International co-publications* represents S&T openness. Together, both indicators provide strong evidence that openness is an important favourable context factor for sustainability experiments.

International meetings



Rank	City
1	Lisbon
2	Dublin
3	Copenhagen
4	Amsterdam
5	Athens
6	Stockholm
7	Barcelona
8	Zurich
9	Vienna
10	Prague
11	Paris
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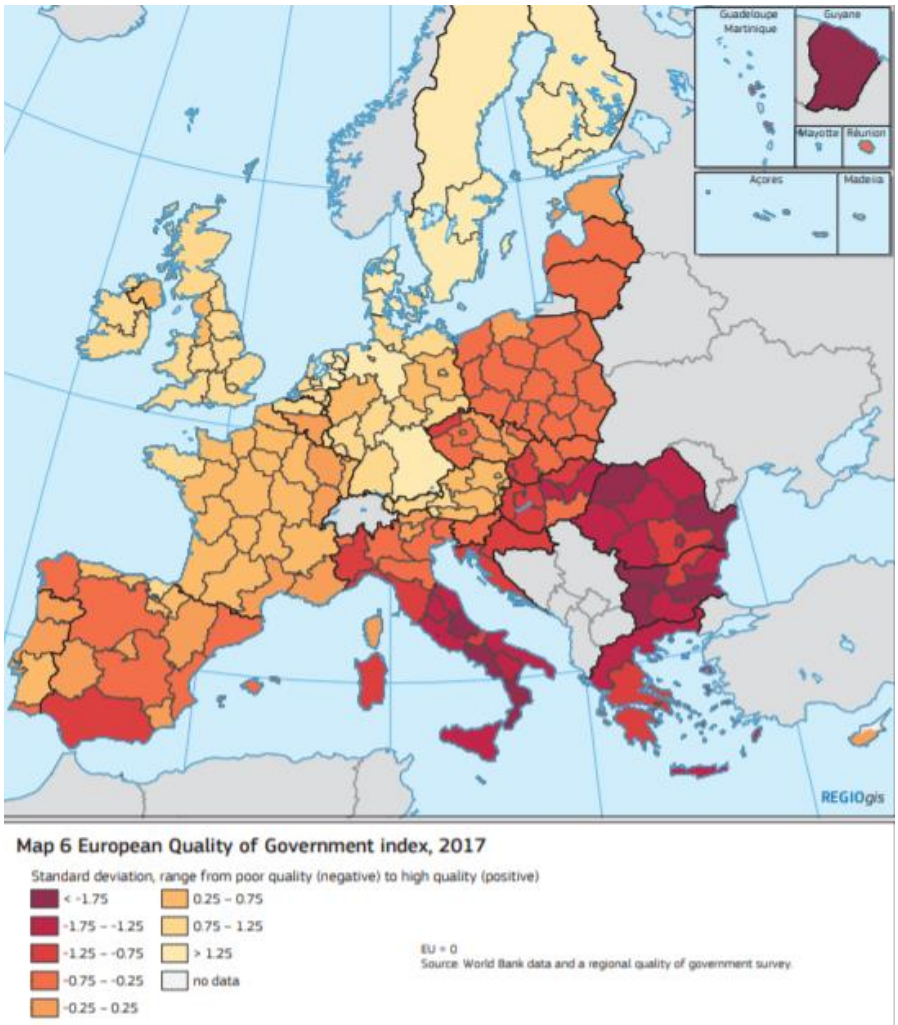
13	Rotterdam
14	Brussels
15	Gothenburg
16	Nijmegen
17	Berlin
18	Madrid
19	Milan
20	Frankfurt am Main
21	Warsaw
22	Rome
23	Naples
24	London
25	Cologne
26	Birmingham
27	Bucharest
28	Istanbul
29	Moscow

No correlation was measured between international meetings and the other *International meetings* indicator *International cultural festivals*. Interestingly, positive correlations were found with *Hipster culture (0,476*), Jobs in creative sectors (0,368*), Makerspaces (0,446*) Coworking spaces (0,802**), Human rights (0,400*)* and *International co-publications (0,395*)*. The first three have already been discussed under the map of coworking spaces. The latter two refer to openness. An explanation for this relationship could be that regions which host many international meetings are generally more respectful towards alternative ways of thinking and living (reflected by human rights) and more open to exchange knowledge with the aim to increase its innovative capacity (reflected by international co-publications). Lastly, *TMNs (0,404*)* positively correlated with International meetings, both indicators that refer to the networking capacity of a region.

The strong correlation between the dependent variable and *International meetings* supports the assumption of our conceptual model that face-to-face meetings play an important role in urban food sharing experimentation. While it suggests that hosting international meetings is linked with the density of urban food sharing experiments, it remains unclear what its role is in the diffusion of sustainability experiments.

EQI and World Governance Indicators (WGI) Index



Rank	City
1	Zurich
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4	Amsterdam
5	Copenhagen
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7	Rotterdam
8	Berlin
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10	Frankfurt am Main
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20	Madrid
21	Warsaw
22	Milan
23	Naples
24	Rome
25	Bucharest
26	Athens
27	Thessalonica
28	Istanbul
29	Moscow

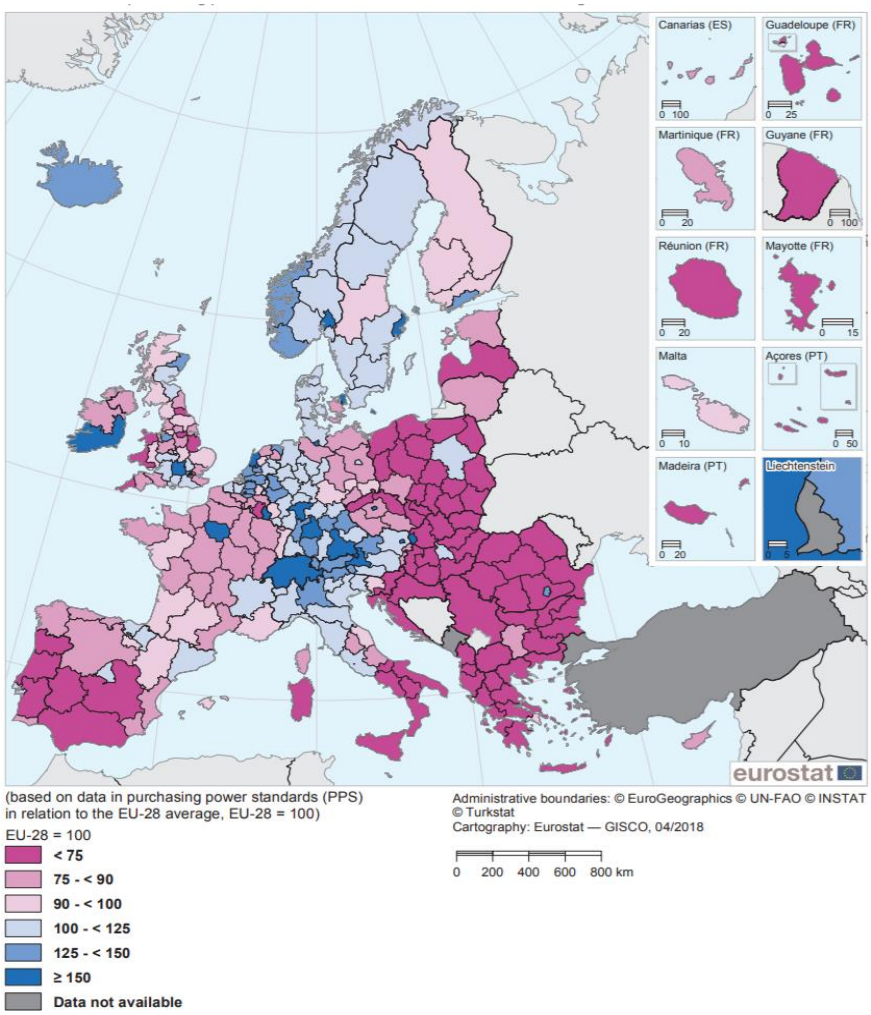
Source: Seventh report on economic, social and territorial cohesion.

Although the map above displays the EQI Index of 2017 and not the WGI Index, it provides an idea of the distribution of the quality of government across Europe. Quality of government is not uniformly spread within each country. For instance, northern Italy (including Milan) performs better than Mid- and Southern Italy (including Rome and Naples). In general, Northwestern Europe performs best.

EQI Index and WGI Index both negatively correlate with the other Quality of government indicator *Poverty and social exclusion (-0,663** and -0,469** respectively)*. Strongest correlations (above 0,5) were observed for *University-industry collaboration (0,748**), Lifelong learning (0,626**), Makerspaces (0,532**), Human Rights (0,704**), International co-publications (0,524**)* and *Internet access (0,623**).*

The results support hypothesis 3a: the density of food sharing experiments is higher in city-regions characterised by a higher quality of government. Thereby, it provides evidence for the assumption that food sharing occurs most often in city-regions with a broadly supportive governing structure for activities which relate to food and sustainability (Davies et al., 2017b). High quality of government also proves to be a fundamental condition for other favourable context factors. It results in less corruption and stronger institutional arrangement (Rodríguez-Pose and Di Cataldo, 2015), which are crucial for developing policies and institutions to support sustainability experiments. Unfortunately, it could not be examined whether the quality of government is more important for guided experiments than for grassroots experiments.

GDP per capita (PPS)



Rank	City
1	Brussels
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3	London
4	Dublin
5	Prague
6	Paris
7	Stockholm
8	Amsterdam
9	Copenhagen
10	Frankfurt am Main
11	Vienna
12	Warsaw
13	Bucharest
14	Cologne
15	Milan
16	Rotterdam
17	Madrid
18	Berlin
19	Gothenburg
20	Rome
21	Barcelona
22	Nijmegen
23	Istanbul
24	Lisbon
25	Moscow
26	Athens
27	Birmingham
28	Naples
29	Thessalonica

Source: Eurostat.

The GDP of the 29 city-regions is not uniformly spread. For example, in Spain, Germany and Italy there are large cross-regional differences in GDP levels. In general, it stands out that capital city-regions have a relatively high GDP compared to non-capital regions.

As hypothesised in our conceptual model, the density of urban food sharing experiments tends to be higher in city-regions which are characterised by high levels of economic well-being.

Besides its correlation with food sharing experiments, GDP also correlates with several other indicators, suggesting that a high GDP often goes hand in hand with excellent performance of other indicators. Statistically highly significant correlations (above 0,5) were observed for *Employment in high-tech sectors (0,602**)*, *CD applications (0,567**)*, *Tertiary education (0,669**)* and *Internet access (0,563**)*.

According to hypothesis H3b, city-regions with a high level of economic well-being tend to host more urban food sharing experiments. This is supported by the positive significant correlation between the density of urban food sharing experiments and *GDP*. The exact reason for this relationship is hard to point out, given the complexity of variables that may influence a city-region's GDP. What the analysis suggests is that food sharing mainly occurs in Northwestern Europe, where city-regions perform structurally better on factors such as skilled labour, sustainability and citizen well-being and quality of government than city-regions in Eastern and Southern Europe.

In addition to the results presented above, the analysis shows that city-regions with a high density of urban food sharing experiments generally perform well on a wide range of context factors, while those with a lower number of experiments per capita perform worse of these context factors. Although some indicators show no statistically significant relationship with the dependent variable, they do show that such city-regions offer more favourable environments in general. To illustrate, Zurich has the highest average density of experiments and ranks in the top five of 18 different indicators. At the same time, Moscow, Naples and Thessalonica rank at the bottom in terms of experiments per capita and do not rank in the top five of one single indicator. However, it should be noted that there are also city-regions which have a high density of experiments but do not perform well on most of the context factors. Cologne is a good example of this. At the same time, Stockholm has 20 indicators in the top five but does not rank that high in terms of experiments per capita. While the case of Cologne might suggest that food sharing may be caused by other factors not incorporated in this study, the latter might suggest that favourable factors for experimentation are present, but that experimentation might be hindered by other factors. Section 6 provides in-depth profiles of both cities and attempts to identify possible causes for these results.

Fig. 5 shows the number of indicators which are in the top five performance by type of favourable context factor. It becomes clear that city-regions with only a few best-performing indicators tend to underperform on quality of government, economic-wellbeing or internet penetration rate. Appendix F provides a complete overview of all top five indicators per city-region.

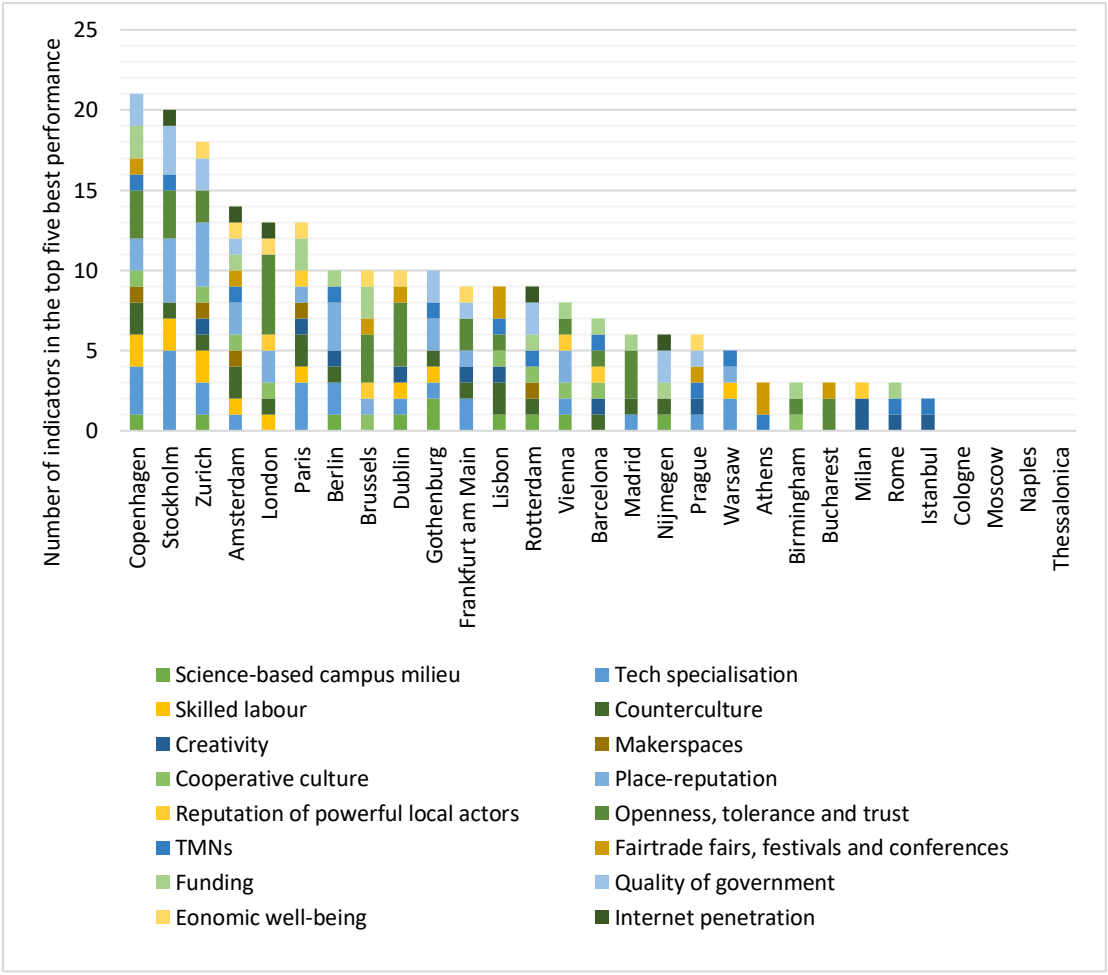

Fig. 5. City performance by favourable context factors.

5.2. Findings in relation to the conceptual model

The results show that there is a variety of context factors that correlates significantly with the density of food sharing experiments. The analysis found evidence for the following favourable context factors to have an influence on the number of food sharing experiments per capita: *science-based campus milieu, technological specialisation, skilled labour, counterculture, creativity, cooperative culture, place-reputation, openness, international meetings, quality of government* and *economic well-being*. Only the factors *makerspaces, reputation of powerful local actors*, *funding* and *internet penetration rate* did not show a significant relationship with the incidence of food sharing experiments.

Based on the result, both hypothesis 1a and 1b cannot be confirmed nor be rejected because city-regions do not show a clear orientation towards one specific habitat. Rather, frontrunner regions tend to host a variety of favourable context factors, which suggests the presence of multiple habitats in one city-region. The analysis procedure did not allow us to demonstrate a linear effect between the density of food sharing experiments and habitats favourable for grassroots innovation as well as habitats which facilitate experiments for social innovation. Nevertheless, city-regions characterised by a high number of food sharing experiments did generally perform well on factors reflecting the right and lower side of the quadrant in Fig. 2.

According to Hypothesis 2, the density of urban food sharing experiments is higher in city-regions which host favourable harbour conditions. The analysis provided support for this hypothesis. Three out of six harbour factors significantly correlated with the density of food sharing experiments. While city-regions with the highest number of food sharing experiments per capita performed well on several harbour indicators, city-regions characterised by a low density of food sharing experiments did perform much worse on the harbour indicators. The most important harbour factors were *Place-reputation* and *Openness*.

The analysis supports hypothesis 3a and 3b: the density of urban food sharing experiments is higher in city-regions which are characterised by a high quality of government and high levels of economic well-being. Thereby, the paper produces novel theoretical insights. However, the way in which both *Quality of government* and *Economic well-being* become favourable context factors for sustainability experimentation is still unclear and therefore deserves more attention. Hypothesis 3c, however, is not supported by the analysis. Though, it did show that a city-region's internet penetration rate strongly depends on *quality of government* and *economic well-being.*

5.3. Reflection on the conceptual model

This section critically reflects on the distinct components of the conceptual model: 'favourable context conditions' for experimentation, the typology of sustainability experiments, and the habitat and harbour concepts.

This paper used the concept of *favourable context factors* to examine the geographically uneven distribution of food sharing experiments. The study started by identifying favourable context factors for sustainability experimentation based on different kinds of literature, including transition management, regional innovation systems, grassroots innovation and more. Each of these theories provided a set of factors argued to be important facilitators of sustainability experiments. Together, these factors have been incorporated in the conceptual model to examine whether they influence the emergence, development and diffusion of urban food sharing experiments. Results indicate that there are indeed a number of context factors which correlate significantly with the density of food sharing experiments across European cities. Most cities with a high density of food sharing experiments

generally had a large number of indicators in the top five for each indicator. This was also the other way around. Thereby, this study supports the findings of earlier studies that specific local and regional context conditions could be used to explain where experiments are likely to emerge (e.g. Håkansson, 2019; Torrens et al., 2018b; Van den Heiligenberg et al., 2018). Although this paper provided more structure in the heterogeneity of context factors, there might be a large number of other factors that could potentially explain the incidence of sustainability experiments.

The *typology of sustainability experiments* provided a useful analytical framework to analyse the influence of a set of context factors that reflected distinct favourable environments for sustainability experimentation. Yet, when comparing the findings from urban food sharing experiments with the typology of sustainability experiments, the contrast between different habitats becomes less visible. In line with Van den Heiligenberg et al. 2018, frontrunner regions in food sharing experimentation essentially represented mixed forms of different habitats. They did not show a clear orientation towards the habitats favourable for either grassroots experiments or experiments for social innovations.

The *habitat* concept proved to be useful to analyse spatial context factors facilitating the emergence and development of sustainability experiments. However, it proved not to be possible to identify what type of habitats were hosted by each of the cities within the sample. While some city-regions performed slightly better on context factors favourable for technological experiments, most cities performed well on a mixture of context factors and did not show a clear orientation towards one specific habitat. Similar to Van den Heiligenberg et al. (2018), the results suggest that cities are characterised by a unique combination of favourable context factors. This implies that 1) habitats may overlap and 2) cities may host more than one habitat. In relation to the habitat factors, more research into distinct favourable environments for different types of sustainability experiments would strengthen the foundations of the still undeveloped habitat concept, and support the framework of Van den Heiligenberg et al. (2018).

The *harbour* concept was introduced by Torrens et al. (2018a) and slightly adapted in this paper. Results suggest that there is indeed a relationship between harbour factors and the density of food sharing experiments. However, the SHARECITY100 Database did not include information about the success or transfer of individual experiments. Therefore, it was not possible to examine the effect of harbour factors on the diffusion of food sharing experiments. Instead, harbour factors were included to examine the incidence of experiments with the underlying idea that experiments emerge at those locations which also host favourable conditions to diffuse the experiments after initial success.

The *habitat* and *harbour* concepts proved useful to examine the influence of context factors argued to be favourable for the emergence, development and diffusion of sustainability experiments. Yet, the delineation of both concepts deserves more attention. In other words, does the notion of isolation vs. openness hold in reality? While this paper distinguished both concepts for analytical reasons, habitats and harbours may overlap geographically in real life, which might have important consequences for policymaking.

In sum, the conceptual model developed in this paper serves as a first attempt to systematically analyse sustainability experiments in a variety of contexts. However, the foundations of the model, including the habitat and harbour concepts, are still underdeveloped. Therefore, scholars are invited to further elaborate on both concepts based on empirical evidence from other sustainability experiments.

5.4. Limitations of the indicators

This section briefly discusses the most notable limitations of the indicators used in the analysis. It starts by highlighting two general limitations of the indicators and subsequently discusses the suitability of the indicators that deserve extra attention.

An important limitation of the indicators refers to the availability of data and is twofold. On the one hand, there were few publicly available databases which contained local and regional data. As a result, the choice for suitable indicators was limited. Especially indicators for creativity and counterculture were sparse. Nevertheless, it proved to be possible to cover all favourable factors for sustainability experimentation that were discussed in Section 2. Only two indicators were included on country-level: *Human rights* was used because of its ability to reflect well the theoretical concept of cultural openness, and the *WGI Index* was used to support missing data from the *EQI Index*. On the other hand, it was sometimes difficult to find indicators that represented well the favourable factors for sustainability experimentation. Especially for the social factors (e.g. counterculture and creativity), this proved to be hard because of limited data availability. This asked for a creative approach towards finding suitable indicators.

A second limitation concerns the lack of city-level data. In cases where no city-level data were available, NUTS 3 and NUTS 2 data were used. However, these are likely to reflect an underestimation of the actual performance on context factors of a city, because urban areas are presumed to perform better on a wide range of context factors than non-urban areas. Only for *Transition town initiatives* and *Poverty and social exclusion,* this might not be the case.

University-industry collaboration

Since almost all cities in the sample hosted more than one university that was listed in the Leiden Ranking, university-industry collaboration was calculated by adding up the proportions of the publications of a university co-authored with one or more industrial partners and denominating it by the number of universities in that respective city. However, differences in university-industry collaboration between universities in one city-region generally showed little variation and thus provided a good indication of the degree of collaboration between universities and industry. More importantly, it is doubtful to what extent university-industry collaboration actually reflects the presence of a science-based campus milieu. However, no other indicator for a science-based campus milieu was found.

The average number of universities per capita

It is questionable whether this indicator is a suitable measure for a science-based campus milieu. It solely focuses on university campuses and neglects campuses without a university such as tech parks, science parks and innovation centres. Moreover, the density of universities listed in the Leiden Ranking 2018 does not mean per se that more science campuses are located in the region. Nevertheless, the results show a highly significant relationship between the density of urban food sharing experiments and the average number of universities, which might suggest that it is mostly the medium-sized cities in the sample which perform well.

Hipster culture

Hipster culture was intended to represent alternative lifestyles, one of the five dimensions of counterculture. However, it is questionable whether this indicator is a suitable proxy for counterculture. The hipster index examines the number of vegan eateries, coffee shops, tattoo

studios, vintage boutiques, and record stores in cities worldwide. It focusses on commercial activities, which seem not to connect to counterculture. Moreover, hipsters may not always show a radically alternative way of living. Instead, the hipster movement of today tends to involve any "young professional, trendy urbanite and creative in the search for healthy, green and 'authentic' consumption choices" (Hubbard, 2016, p. 1). Nevertheless, *Hipster culture* was argued to be a potentially useful indicator to reflect the alternative lifestyles dimension of counterculture.

Inter-firm collaboration

This indicator measures the degree to which innovative SMEs collaborate with others as a percentage of the absolute number of SMEs. Therefore, a limitation of this indicator may be the focus on top-down technological cooperation and a neglect of grassroots cooperation. However, this indicator was included since there are hardly any non-scientific metrics that represent a cooperative culture in a region.

Sustainable Cities Index, Cities in Motion Index and Smart Cities Index

These three indices were included because of their ability to represent the place-reputation of cities, referring to sustainable, green, smart and liveable cities. While the overlap between indicators has been minimised intentionally, some indicators were included more than once. However, the operationalisation and sources differ, as is displayed in Table 4.

Table 4. Similarities between indicators.

Indicator	This paper	Sustainable Cities Index	Cities in Motion Index	Smart City Index
R&D intensity	Gross domestic expenditure on R&D (GERD) as % of GDP			Investment to R&D as % of GDP (Global Innovation Index 2017)
Tertiary education	% of population (25-64y) with tertiary education (ISCED 2011 levels 5-8)	% of population with tertiary education (Barro and Lee, various national sources)	% of population with secondary and higher education (Euromonitor)	
Quality of government	EQI Index and WGI Index		Corruption Perceptions Index. (Transparency International); The strength of legal rights index (World Bank)	
Green urban areas	Share of green urban areas and forests as a % of total land area	Green space as % of city area (Siemens Green City Index)		
University ranking	Average number of a university's appearances in QS, Shanghai, Leiden and Times rankings	QS university ranking		
International meetings	Number of international meetings per 100,000 city inhabitants (ICAA)		Number of international conferences and meetings (ICAA)	
GDP	PPS per inhabitant	GDP per capita (Brookings Global Monitor)	GDP in million U.S. dollars at 2014 prices (Euromonitor)	

Interpersonal trust

While interpersonal trust may reinforce cooperation and indicate the presence of an open culture, high levels of interpersonal trust could also be disadvantageous. Using the concept of social proximity, Boschma (2005) describes how too much trust in relationships may lead to an underestimation of opportunistic behaviour and situations in which people are locked into their routines at the expense of their own capacity to learn and innovate. This implies that interpersonal trust would be a favourable

harbour factor when actors involved in food sharing networks know how to reach a balance in their trust-based relations.

TMNs

The assumption behind this indicator was that cities which participate in global city networks, so-called Transnational Municipal Networks (TMNs) share expertise and policy know-how on sustainability experimentation and are therefore better aware of the experiments carried out in other places. This makes them more receptive to the transfer of sustainability experiments. However, a limitation of this indicator refers to the role of local and regional governments, which is significantly more important in Northwestern Europe than in Southern Europe (Nemec and de Vries, 2015). This would imply that it is questionable if TMNs really contribute to the diffusion of sustainability experiments in city-regions, especially in Southern Europe.

Venture capital

Hardly any indicators on funding were appropriate. Though, three indicators for funding were derived from the Regional Ecosystem Scoreboard: *Venture capital*, *Availability of funds from public sector and Structural Funds dedicated to entrepreneurship and SMEs*. However, the role of venture capital could be questioned. Davies et al. (2017b) found that the majority of food sharing initiatives are employed by organisations operating outside the mainstream market and do not involve any capitalist and market transactions and so the role of venture capital remains minimal. Still, some initiatives were employed by for-profit organisations and therefore *Venture capital* was included.

GDP

This paper used the GDP of NUTS 2 regions in the analysis. However, it should be noted that considerable differences were observed between the GDP of metropolitan areas, NUTS 3 and NUTS 2 regions. For example, Amsterdam and Frankfurt entered the top five on NUTS 3 level, whereas Copenhagen, London and Stockholm entered the top five on metropolitan area level. This can be explained by the fact that the GDP on NUTS 3 and NUTS 2 level also includes the GDP of the area surrounding the cities, which often have a lower GDP. For example, the GDP between inner and outer London differs considerably.

While this study found evidence that a higher GDP is associated with a higher density of food sharing experimentation, it could also be argued that food sharing mainly occurs in municipalities and neighbourhoods characterised by a relatively low GDP. Recent literature supports this idea and stresses that sustainability initiatives, such as urban agriculture, green housing and waste management, emerge in deprived urban neighbourhoods where environmental quality and liveability is low (Anguelovski, 2015; Håkansson, 2019). A reason could be that these initiatives are less related to a sustainable lifestyle and more focussed on long-term social improvement and short-term immediate needs (Håkansson, 2019).

In sum, several of the indicators proposed in this paper entail limitations that are worth noting. These limitations concern the limited availability of suitable indicators and the ability of these indicators to represent well the favourable context factors for experimentation. Yet, this paper does not seek to propose a fixed set of indicators to reflect favourable factors for sustainability experimentation. Rather, it does a first attempt at operationalising these factors to examine them in a quantitative way.

6. Regional profiles

This section complements the findings from the quantitative analysis by providing a more complete picture of the environment for experimentation in two contrasting city-regions: Cologne and Stockholm. Cologne was chosen because it has a high density of food sharing experiments but does not perform well on most of the context factors examined in this paper. Stockholm was chosen because it appears to have favourable habitats and harbours for experimentation but, at the same time, it has a relatively low density of food sharing experiments.

6.1. Cologne

Cologne hosts 66 food sharing experiments, of which 13 are guided, 52 are grassroots and 1 is a hybrid of the two. Most experiments focus on the sharing of land (e.g. urban kitchen gardens) and knowledge, mainly through selling and gifting by associations. On average, the city of Cologne hosts 1 food sharing experiments for every 16.000 people. Cologne ranks with no single indicator in the top five of each indicator. So why then does Cologne host relatively many urban food sharing experiments?

The reason for this can be found in the role of Foodsharing e.V., a grassroots initiative aiming to prevent food waste in private households, supermarkets, and restaurants through the sharing of food surpluses (Foodsharing, 2019). Foodsharing e.V. was established in Cologne in 2012 by a voluntary association (Kölmel et al., 2019). A key player in the establishment of Foodsharing e.V. was Valentin Thurn, a documentary film-maker who had raised awareness about the problem of food waste in Europe with his documentary called "Taste the Waste"[2] (Ganglbauer et al., 2014). Following the documentary, the association started a Facebook group which was followed up by an online platform called Foodsharing.de, where people from all over Germany could share their food with each other. At the end of the founding year 2012 Foodsharing.de already had 1319 members, spread across Berlin (166), Cologne (133), Frankfurt am Main (67), Munich (60) and Hamburg (55) (Kölmel et al., 2019). In 2018, the Foodsharing e.V. had more than 200.000 registered users and 25.000 "food savers" who rescued 13 million kg of food (Morrow, 2018). The possible reasons for this rapid increase in users were *(1) the visibility in public space*; the presence of stickers, posters, information stands and reports in mass media raised public awareness, and (*2) the fact that Foodsharing.de was socially accepted and already had an established infrastructure*, thus reducing hurdle to participate (Kölmel et al., 2019).

Kölmel et al. (2019) examined the distribution of Foodsharing.de based on sociodemographic characteristics of the districts of Cologne. The authors demonstrated significant positive correlations between "Foodsharing" communities and *m^2 rent, the proportion of 21-34-year-olds and the voting rate of the Green Party*. This suggests that Foodsharing occurs in districts with high student populations. On a national level, "Foodsharing" communities were located in urban areas with *above-average student populations* such as Göttingen, Darmstadt and Heidelberg and in *popular and trendy districts* in Berlin, Cologne, Leipzig, Hamburg and the inner districts of Bonn and Freiburg. This is also shown in Fig. 6.

In sum, several context factors can be identified which might explain why Cologne hosts many food sharing initiatives while performing below-average on many spatial context factors. Firstly, the case demonstrates the importance of *powerful local actors* or *champions who lead the way* for the emergence of grassroots initiatives. Secondly, it shows how *advertisements* and *mass media* (including

[2] http://tastethewaste.com/

social media such as Facebook) can play a large role in the rapid diffusion of grassroots initiatives. Thirdly, it emphasises the importance of community- and network-building through personal contacts to enhance the diffusion process. Lastly, it appears that "Foodsharing communities" are concentrated in *university districts*. However, the authors fail to provide a reason for this concentration.

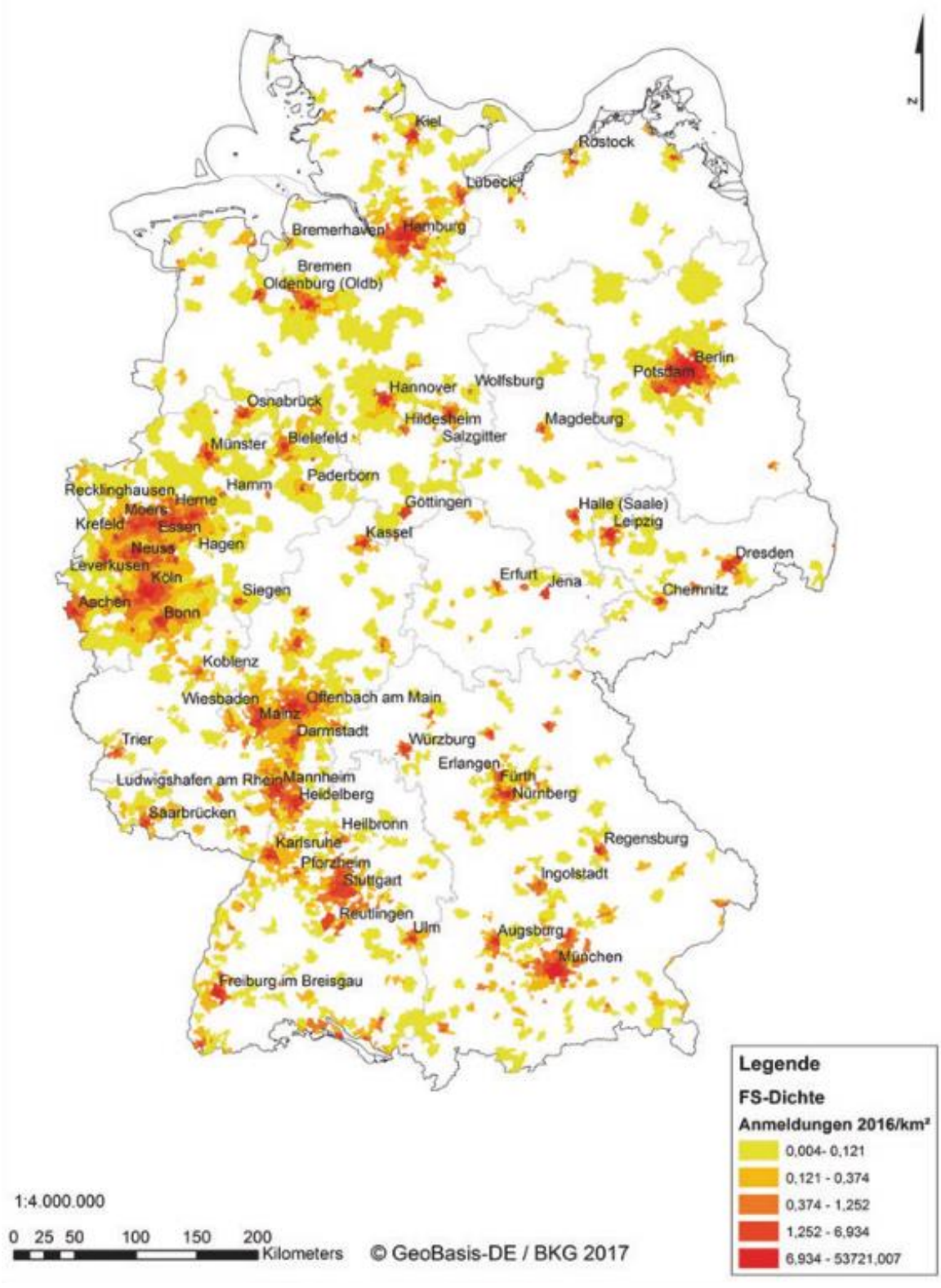

Fig. 6. The density of 'Foodsharing.de' registrations in 2016 (Kölmel et al., 2019).

6.2. Stockholm

Stockholm hosts 26 food sharing experiments, of which 6 are guided and 20 are grassroots. Most of the experiments focus on the sharing of knowledge, mainly through gifting by informal organisations. On average, the city of Stockholm hosts 1 food sharing experiments for every 33.000 people. As shown in Fig. 5, Stockholm ranks with 20 out of 41 indicators in the top five, which is exceptionally well.

Technological specialisation and skilled labour

Stockholm ranks in the top five of all five technological specialisation indicators (i.e. *Employment in high-tech sectors, High-tech patent applications, ICT patent applications, CD applications* and *R&D intensity*) and both skilled labour indicators (i.e. *Tertiary education* and *Lifelong learning*). Interestingly, Stockholm by far outperforms the other cities in the sample on *High-tech patent applications* (153 per 1 million inhabitants compared to an average of 27) and *ICT patent applications* (198 per 1 million inhabitants compared to an average of 37). These findings are in line with the high innovative capacity and technological focus of the Stockholm region. Stockholm is considered an "Innovation Leader" according to the European Regional Innovation Scoreboard (RIS) 2016 (Hollanders et al., 2016). There are several strong research universities, e.g. Royal Institute of Technology (KTH), Karolinska Institutet (KI), Stockholm University (SU), Södertörn University and Stockholm School of Economics, which work closely with many organisations, for example incubators (STING, KIAB and SUIAB), innovation support offices (KI, KTH and SU) and science parks (Kista Science City, Karolinska Institute Science Park and Södertälje Science Park) (European Commission, 2019). Furthermore, the region also has a strong position in knowledge-intensive sectors such as ICT, financial services, business consultations and transportations but also in environmental technology (European Commission, 2019).

The relationship between high-tech/knowledge-intensive sectors and skilled labour can be thought of as a mutually reinforcing relationship. On the one hand, high-tech and knowledge-intensive jobs require skilled and highly educated workers. On the other hand, regions with a pool of skilled labour are attractive to any firm, especially firms in innovative and technology-based industries (Florida, 2002a).

Place-reputation

Stockholm ranks in the top five of all five place-reputation indicators (i.e. *Sustainable Cities Index, Smart City Index, Regional green economic performance* and *Green urban areas*). Compared to the other cities in the sample, Stockholm even ranks on top in terms of *Regional green economic performance* (1,17 compared to an average of 0,95) and *Green urban areas* (56% of total land area compared to an average of 18%). Stockholm's commitment to sustainability led to it being the first city to win the European Green Capital Award in 2010. Stockholm was awarded with this prize for its continuous contribution to the fight against climate change, low noise levels, innovative waste management, the fact that 95% of the population lives less than 300 metres from green urban areas and the target of being a fossil fuel-free city in 2015 (City of Stockholm Executive Office, 2011).

Openness

Stockholm ranks in the top five of three out of six openness indicators (i.e. *Tolerance of foreigners, Interpersonal trust* and *International co-publications*). Compared to the other cities in the sample, Stockholm has the highest tolerance of foreigners (58% compared to an average of 31%). Furthermore, Stockholm is characterised by its high respect for human rights. Homosexual relations have been legal since 1944 and same-sex couples have been able to adopt since 2003 and get married since 2009

(Swedish Institute, 2019). Moreover, Sweden was the first in the world with freedom of the press (1766) and is at the top of global press freedom rankings.

Quality of government

Stockholm ranks in the top five of three out of three quality of government indicators (i.e. *EQI, WGI Index* and *Poverty and social exclusion*). This demonstrates the presence of strong institutional structures and high overall quality of government, which proved to be fundamental factors facilitating the emergence of sustainability experiments.

Counterculture and internet penetration rate

Other well-performing context factors include counterculture and internet penetration rate. With five intentional communities in the neighbourhood, Stockholm performs considerably better than most other city-regions in Europe. It shows that alternative lifestyles are accepted and tolerated. Furthermore, in Stockholm, 97% of all private households have access to the internet at home, which is the largest share of all city-regions in Europe.

Possible hindering factors

Although Stockholm appears to host favourable habitats and harbours for experimentation, there could be several factors hindering Stockholm from experimenting with food sharing. The first could be related to its strong technological specialisation. Innovation and technology are the focus areas of the Stockholm region, while this might be at the expense of social innovation. In turn, an explanation for the low degree of social innovation could be that social innovations react to societal problems, which may be less present in urban areas without much poverty and social exclusion like Stockholm. This corresponds with Anguelovski (2015), who argues that community-based activism for better environmental quality and liveability mainly takes place in distressed urban areas, with fewer environmental services (e.g. parks, forests, community centres) than wealthier areas.

Second, researchers found that there is a lack of cooperation and communication between the city of Stockholm and grassroots movements (Dipesh Dougar et al., 2015). Causes for this shortcoming are the *lack of trust and cooperation* between the city of Stockholm and the grassroots movement and the *excessive bureaucratic procedures* that hinder the process for requesting grants and general support for grassroots movements. These factors could have hindered the emergence of food sharing experiments as well. The lack of trust here is different from *Interpersonal trust*, as the latter refers to trust in fellow citizens in general.

7. Discussion

This paper seeks to contribute to the *geography of transitions* by identifying what spatial context factors may underly the uneven distribution of sustainability experiments. The main finding is that the conceptual model developed in this paper provided a solid basis to analyse favourable context factors for sustainability experimentation. This section highlights the main contributions of this paper, limitations, avenues for future research and policy implications.

7.1. Contributions to the literature

This paper makes two contributions to the literature. Theoretically, the paper develops a conceptual model which can be used to study favourable conditions for different types of sustainability experiments in different contexts. The conceptual model is based on the work of Van den Heiligenberg et al. (2017; 2018), which is extended by incorporating the harbour concept and three additional context factors. These additional factors are *quality of government, economic-wellbeing* and *internet penetration rate*. The analysis showed significant correlations between the density of experiments, and quality of government and economic well-being, suggesting that both are important facilitators of sustainability experiments. These factors deserve more attention when studying the geography of sustainability experiments.

Methodologically, the paper complements the existing range of qualitative studies by employing a first quantitative approach to analyse sustainability experiments in Europe. It examines the relationship between the density of urban food sharing experiments and a wide range of largely neglected demographic, socio-economic, and socio-cultural factors. In doing so, it provides more structure in the heterogeneity of favourable environments for experimentation, which still lacks theoretical coherence (Torrens et al., 2018a).

7.2. Limitations and future research avenues

The paper has several limitations that should be kept in mind when interpreting the results. An important limitation concerns the dataset used. The SHARECITY100 Database only included a limited number (29) of medium to large cities in Europe which are active in food sharing experimentation. This has a few implications. First, contrasts in spatial context factors could have been stronger when comparing cities with and without food sharing experiments. However, conducting a systematic search of cities with and without food sharing experiments was beyond the scope of this paper. Nevertheless, large differences were observed by examining the extreme ends of the sample. Second, there might be far more cities or towns in Europe which are active in urban food sharing experimentation. Especially small towns and rural areas deserve more attention as those are often subject to local community-based transition projects such as those being part of the Transition Town Movement (Feola and Butt, 2017). Moreover, a larger sample would have made it possible to conduct a regression analysis, which would have made it easier to identify patterns in spatial context factors and would have improved the reliability of the results. An important avenue for future research is to further explore the geographically uneven distribution of food sharing experiments in a larger number of cities and towns in Europe, or even globally. It would also be interesting to focus on different patterns of experimentation within large cities itself, because of the considerable differences in community activism and urban sustainability experimentation between deprived and wealthy urban

neighbourhoods (Anguelovski, 2015; Håkansson, 2019). Especially neighbourhoods characterised by poverty and social exclusion can offer 'fertile ground' for the development of new food sharing initiatives or businesses which specifically focus to serve those who live in poverty (Michelini et al., 2018). As suggested by Håkansson (2019), one could employ a classification approach dividing different urban neighbourhoods into clusters depending on their socio-cultural and demographic characteristics. A similar approach has been used by Kölmel et al. (2019), who examined the correlation between "Foodsharing" communities and several sociodemographic characteristics of city districts in Cologne. Lastly, the dataset used did not contain any information about the upscaling of experiments. Future research could use the proposed harbour factors to examine their effect on the upscaling of sustainability experiments.

A second limitation regards the usefulness of the habitat and harbour concepts. Although this has been addressed earlier, it remains important to emphasise. Both the results of Van den Heiligenberg et al. (2018) and those in this study suggest that cities exhibit a mixture of favourable context factors. As a consequence, the analytical contrast between habitats becomes less visible. However, these results are only based on a few cases, with specific themes. With regard to the generalisability of urban food sharing as a sustainability experiment, it would therefore be fruitful to study and compare other types of experiments, being experiments for either technological or social innovation. For example, sustainability experiments in the fields of energy and transport may require different context factors than urban food sharing.

One more avenue for future research can be suggested. Future research should identify other factors which could potentially explain the incidence of sustainability experiments. However, research into favourable context factors alone is not sufficient to eventually better understand how sustainability experiments may successfully contribute to a transition towards more sustainable consumption and production systems. Local and regional policymakers should evaluate and learn from sustainability experiments' internal interactions and their external impact, both argued to be the most important factors for success (Ornetzeder and Rohracher, 2013).

7.3. Policy implications and recommendations

This paper provided scientific insight into why sustainability experiments emerge more in some locations than in others. Although more research into favourable environments for sustainability experimentation is required, the findings of this paper may be a next step forward in helping regional stakeholders (e.g. policymakers, local and regional governments) involved in urban sustainability experimentation to improve the contextual environment for sustainability experiments. However, the ability to influence these factors may be varied. On the one hand, factors such as participation in global networks, international meetings and funding might be relatively easy to influence by regional stakeholders. On the other hand, it may be more difficult to influence factors such as technological specialisation, cooperative culture, openness, quality of government and economic well-being, as such localised capabilities often depend on historical and path-dependent developments (Maskell and Malmberg, 1999).

Another implication for policy is that this paper provides 'best practice' material for city-regions involved or not yet involved in sustainability experimentation. It shows how the incidence of experiments is related to a wide variety of favourable context factors. Together with the two regional profiles, it provides relevant insights that can be used to develop favourable environments for sustainability experimentation. An important lesson from the urban food sharing case is that the use

of ICT (e.g. social media and online platforms) can play a considerable role in raising public awareness, building wide support and ultimately diffusing sustainability initiatives. Therefore, stakeholders involved in sustainability experimentation are encouraged to stimulate the use of ICT to increase the impact of their initiatives.

A final recommendation regards the sparse documentation of individual sustainability experiments. The SHARECITY100 Database is one of the very few publicly available databases which contains information about sustainability experiments. To better understand why certain experiments succeed or fail, it is recommended to keep track of every individual initiative and document their process. This would enable researchers to further explore the success factors of sustainability experiments and would provide actors involved in sustainability experimentation with relevant insights on how to improve the success and increase the wider impact of their experiments.

8. Conclusions

This paper has systematically analysed the geographically uneven distribution of sustainability experiments by identifying and subsequently examining various demographic, socio-economic, and socio-cultural factors to explain why certain city-regions are frontrunners in urban sustainability experimentation. By employing a first quantitative approach, it addressed the research gap of how spatial contexts affect the emergence, development and diffusion of urban sustainability experiments. Thereby, it complements earlier qualitative studies and brings greater coherence to our understanding of the spatial context factors for sustainability experimentation.

The analysis has found that urban food sharing experiments emerge, develop and diffuse in a variety of contexts. In general, urban food sharing experiments are clustered in Northwestern Europe, in city-regions characterised by their devotion to sustainability and high quality of living. The paper showed that the density of food sharing experiments is associated with a variety of favourable context factors, including technological specialisation, skilled labour, creative employment, cooperative culture, counterculture, place-reputation, openness, international meetings, quality of government and economic well-being. Most of these factors have already been described in existing studies in the field of sustainability transitions and economic geography. However, this paper provides a novel contribution to the literature by suggesting that quality of government and economic-wellbeing are as well important facilitators for sustainability experiments.

Interestingly, some city-regions (e.g. Stockholm) proved to host a favourable environment for experimentation but did not have a high density of food sharing experiments and vice versa for cities like Cologne, suggesting that there might be other factors influencing food sharing experimentation. Based on a case study of Cologne, a possible reason for the high-density of experiments can be found in the rapid diffusion of the grassroots initiative Foodsharing e.V. Based on a case study of Stockholm, possible hindering factors were a strong focus on technological specialisation and a lack of cooperation and communication with grassroots movements.

The analytical contrast between the distinct habitats proved to be less visible in reality. As a result, the analysis could not confirm the hypotheses that the density of urban food sharing experiments is higher in habitats favourable for either grassroots experiments or experiments for social innovations. Yet, results indicated that these habitats may be present. Furthermore, the results suggest that the density of urban food sharing experiments is higher in city-regions which host favourable harbour conditions. These findings show the usefulness of the habitat and harbour concepts to study experiments in different spatial contexts.

In line with earlier research, this paper provides evidence that in sustainability experimentation, geography matters. However, more research is needed to better understand how favourable context factors facilitate different types of sustainability experiments. Future research avenues should focus on studying a larger sample of sustainability experiments, different types of experiments, differences within cities and the actual upscaling of experiments.

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Appendix A: Indicators database methodology

Raw data

Raw data were collected through various publicly available databases (e.g. Eurostat, ESPON, Leiden Ranking and so on). A large proportion of the raw data were already standardised or even normalised because it was used as part of an aggregated indicator. However, some raw data required manual standardisation. The standardisation procedure is described below.

Standardisation

Some indicators may correlate with the size of the population. For example, the number of coworking spaces may be higher in larger cities than in small cities. To enable cross-city comparability, some indicators were standardised. Indicators were standardised when the correlation with the number of inhabitants was considered relatively high, meaning above 0,3. Indicators that were deemed eligible for standardisation were denominated by the population of the same geographical area as the indicator, i.e. city, NUTS 3 or NUTS 2. Although it was not possible in all cases to use the same year for both the indicator and the corresponding population, those differenced were so marginal that it did not influence the results. Standardised indicators were: *Jobs in creative sectors, Makerspaces, Coworking spaces, Transition town initiatives and International meetings*.

Missing values

The aim was to collect data from 2016. When this was not possible data were used from the year with the least missing data. Preferably, this year had to be close to 2016. When no data were found, data were imputed using multiple imputations in SPSS. First, the Mersenne Twister random number generator was used, with a fixed value of 2,000,000. Second, variables were imputed five times using SPSS's automatic imputation method. When calculating descriptive statistics and Pearson correlations, pooled values were used.

---------- *Access to the indicators database can be obtained by contacting the author* ----------

Appendix B: European cities in the SHARECITY100 Database

Table B1. Overview of European cities in the SHARECITY100 Database and their corresponding territorial codes.

#	City	Country	City Code	NUTS 3 Code	NUTS 2 Code	Number of experiments	Guided	Grassroots	Hybrid
1	Amsterdam	Netherlands	NL002C2	NL329	NL32	29	8	20	1
2	Athens	Greece	EL001C1	EL301-304	EL30	38	5	32	1
3	Barcelona	Spain	ES002C1	ES511	ES51	112	20	91	1
4	Berlin*	Germany	DE001C1	DE300	DE30	127	34	88	5
5	Birmingham	United Kingdom	UK002C1	UKG31	UKG3	24	3	20	1
6	Brussels*	Belgium	BE001C1	BE100	BE10	28	8	20	0
7	Bucharest	Romania	RO001C1	RO321	RO32	12	3	9	0
8	Cologne*	Germany	DE004C1	DEA23	DEA2	66	13	52	1
9	Copenhagen	Denmark	DK001C1	DK011	DK01	22	5	17	0
10	Dublin	Ireland	IE001C1	IE061	IE06	45	11	29	5
11	Frankfurt	Germany	DE005C1	DE712	DE71	54	14	39	1
12	Gothenburg	Sweden	SE002C1	SE232	SE23	14	3	11	0
13	Istanbul*	Turkey	TR012C1	TR100	TR10	35	8	27	0
14	Lisbon*	Portugal	PT001C1	PT170	PT17	35	10	22	3
15	London*	United Kingdom	UK101C1	UKI31-75	UKI3-7	200	57	137	6
16	Madrid*	Spain	ES001C1	ES300	ES30	56	9	47	0
17	Milan	Italy	IT002C1	ITC4C	ITC4	41	14	26	1
18	Moscow*	Russia	-	-	-	13	5	8	0
19	Naples	Italy	IT003C1	ITF33	ITF3	21	9	12	0
20	Nijmegen	Netherlands	NL013C1	NL226	NL22	15	2	12	1
21	Paris	France	FR001C1	FR101	FR10	38	12	25	1
22	Prague*	Czech Republic	CZ001C1	CZ010	CZ01	20	6	14	0
23	Rome	Italy	IT001C1	ITI43	IT4	38	11	27	0
24	Rotterdam	Netherlands	NL003C2	NL33C	NL33	17	4	13	0
25	Stockholm*	Sweden	SE001C1	SE110	SE11	26	6	20	0
26	Thessalonica	Greece	EL002C1	EL522	EL52	11	1	10	0
27	Vienna*	Austria	AT001C1	AT130	AT13	40	13	27	0
28	Warsaw*	Poland	PL001C1	PL911	PL91	18	5	12	1
29	Zurich*	Switzerland	CH001C1	CH040	CH04	42	6	31	5
Total number						1237	305	898	34
Percentage						100%	25%	73%	3%

Source: Eurostat and SHARECITY100 Database. Note: for 13 cities, the NUTS 3 population is identical to the NUTS 2 population; these cities are highlighted with an ''.*

Appendix C: The regional density of urban food sharing experiments in Europe

Table C1 presents the ranking of cities according to the absolute number of experiments and the number of experiments per capita at different geographical levels (city, NUTS 2 and NUTS 3). The top five cities in the database by absolute number of experiments are London, Berlin and Barcelona, Cologne and Madrid. Together they account for over 45% of all 1237 experiments recorded within the 29 European cities. What stands out is the fact that these cities are large metropolitan areas with more than one million inhabitants. Moreover, they are located in only three countries, i.e. the United Kingdom, Germany and Spain.

However, when the number of experiments is examined per capita, it becomes clear that there is considerable variation between geographical levels (city, NUTS 3 and NUTS 2). For example, when looking at the number of experiments per 100,000 city inhabitants, the top five consists of Zurich, Nijmegen, Dublin, Frankfurt and Barcelona, with Zurich having one experiment for every 9162 people. In turn, the top five changes considerably for the other two geographical levels. This is caused by the differences in population size of NUTS 3 and NUTS 2 regions. These results clearly show that one should be careful with choosing the appropriate geographical boundary when examining patterns of sustainability experimentation in European regions.

Table C1. City ranking in absolute number of experiments and experiments per capita.

Rank	Absolute number	City	NUTS 3	NUTS 2
1	London*	Zurich	Frankfurt	Berlin
2	Berlin*	Nijmegen	Berlin	Zurich
3	Barcelona	Dublin	Dublin	Brussels
4	Cologne*	Frankfurt	Copenhagen	London
5	Madrid*	Barcelona	Zurich	Vienna
6	Frankfurt	Lisbon	Brussels	Dublin
7	Dublin	Cologne	London	Prague
8	Zurich*	Athens	Vienna	Barcelona
9	Milan	Copenhagen	Amsterdam	Cologne
10	Vienna*	Berlin	Birmingham	Frankfurt
11	Athens	Amsterdam	Nijmegen	Lisbon
12	Paris	Thessalonica	Barcelona	Copenhagen
13	Rome	Milan	Paris	Stockholm
14	Istanbul*	Stockholm	Prague	Amsterdam
15	Lisbon*	Rotterdam	Athens	Warsaw
16	Amsterdam	Gothenburg	Cologne	Athens
17	Brussels*	London	Milan	Madrid
18	Stockholm*	Brussels	Lisbon	Nijmegen
19	Birmingham	Vienna	Rotterdam	Gothenburg
20	Copenhagen	Birmingham	Stockholm	Rome
21	Naples	Naples	Warsaw	Thessalonica
22	Prague*	Madrid	Thessalonica	Bucharest
23	Warsaw*	Paris	Rome	Rotterdam
24	Rotterdam	Prague	Madrid	Birmingham
25	Nijmegen	Rome	Gothenburg	Milan
26	Gothenburg	Warsaw	Naples	Naples
27	Moscow*	Bucharest	Bucharest	Paris
28	Bucharest	Istanbul	Istanbul	Istanbul
29	Thessalonica	Moscow	Moscow	Moscow

Note: In case a large metropolitan city consisted of several NUTS 3 areas, these areas were all included for this city. In these cases, the NUTS 3 population is identical to the NUTS 2 population; these cities are highlighted with an ''.*

From Table 3 above it can be concluded that urban food sharing experiments appear to be clustered in Northwestern Europe. Countries from Northwestern Europe included in the sample are Ireland, United Kingdom, The Netherlands, Belgium, Northern France, Germany, Denmark, and Sweden and Switzerland. These countries are characterised by a high GDP, quality of government and overall focus on sustainability. The top five cities in terms of experiments per capita on the three geographical levels are located in Northwestern Europe (except Barcelona and Vienna).

Appendix D: Summary of variables and indicators

Table D1. Summary of variables and indicators.

Variable	Description	Metrics	Source	Coverage	Time span	Availability
Dependent variables						
Number of urban food sharing experiments per city population	Number of urban food sharing experiments divided by the total city population	Score	SHARECITY100 Database; Eurostat	City	2016	100%
Number of urban food sharing experiments per NUTS 2 population	Number of urban food sharing experiments divided by the total NUTS 2 population	Score	SHARECITY100 Database; Eurostat	NUTS 2	2016	100%
Number of urban food sharing experiments per NUTS 3 population	Number of urban food sharing experiments divided by the total NUTS 3 population	Score	SHARECITY100 Database; Eurostat	NUTS 3	2016	100%
Indicators						
Habitat						
University-industry collaboration	Average proportion of the publications of a university co-authored with one or more industrial partners[3]	Percentage	Leiden Ranking 2018	City	2013-2016	100%
Universities per capita	Average number of universities in Leiden Ranking per 1 million city inhabitants	Score	Leiden Ranking 2018; Eurostat	City	2013-2016	100%
Employment in high-tech sectors	Percentage of total employment in high-tech sectors (high-technology manufacturing and knowledge-intensive high-technology services[4])	Percentage	Eurostat [htec_emp_reg2]	NUTS2	2016	97%
High-tech patent applications	Three-year-average number of high-tech patent[5] applications to the EPO per 1 million inhabitants	Score	Eurostat [met_pat_eptec]	NUTS 3	2010-2012	97%
ICT patent applications	Three-year-average number of ICT patent applications to the EPO per 1 million inhabitants	Score	Eurostat [met_pat_epict]	NUTS 3	2010-2012	97%

[3] Often more than one university was located in a city-region. In these cases an average score was calculated.

[4] High-technology manufacturing includes NACE Rev. 2: 21, 26, 30.3; knowledge-intensive high-technology services includes NACE Rev. 2: 59, 60, 61, 62, 63, 72 (Eurostat, 2018b).

[5] High-tech includes aviation, computer and automated business equipment, communication technology, laser, micro-organism and genetic engineering and semiconductors (Eurostat, 2018a).

Community design (CD) applications	Three-year-average number of community design applications to the EPO per 1 million inhabitants	Score	Eurostat [ipr_da_popr]	NUTS 3	2013-2015	97%
R&D intensity	Gross domestic expenditure on R&D (GERD) as a percentage of GDP	Percentage	Eurostat [rd_e_gerdreg]	NUTS 2	2015	90%
Tertiary education	Percentage of the population aged 25-64 years with tertiary educational attainment (ISCED 2011 levels 5-8)	Percentage	Eurostat [edat_lfse_04]	NUTS 2[6]	2016	97%
Lifelong learning	Percentage of the population aged 25-64 years who participated in education and training (in the last 4 weeks)	Percentage	Eurostat [trng_lfse_04]	NUTS 2	2016	97%
Intentional communities	Total number of intentional communities	Score	Ecobasa; Global Ecovillage Network; Foundation for Intentional Community	NUTS 2	1991 - present	100%
Hipster culture	Average score based on the number of vegan eateries, coffee shops, tattoo studios, vintage boutiques, and record stores per 100,000 city residents (Hipster Index)	Score (0-10)	MoveHub	City	2018	79%
Transition town initiatives	Number of transition town initiatives per 1 million NUTS 3 inhabitants	Score	Ecolise	NUTS 3	2019	100%
Community action	Percentage of people that belong to local community action groups on issues like poverty, employment, housing and racial equality	Percentage	European Values Survey	NUTS 2	2008	79%
Jobs in creative sectors	Number of jobs in arts, culture, entertainment, media, communication, and other creative sectors per 1,000 city inhabitants (NACE Rev. 2, J, M-N, R-U)	Score	Eurostat [urb_clma]	City	2011 & 2014	83%
UNESCO Creative Cities Network member	Member of UNESCO Creative Cities Network	0 = no	UNESCO	City	2019	100%
Makerspaces	Number of community innovation spaces (makerspaces, hackerspaces, fab labs, repair cafés and other 'maker' hubs) per 1 million city inhabitants	Score	Ananse Group: Atlas of Community Innovation Spaces	City	2018 -2019	100%

[6] Tertiary education at city level had too many missing values.

Coworking spaces	Number of coworking spaces per 100,000 city inhabitants	Score	Coworker.com	City	2019	100%
Inter-firm collaboration	Innovative SMEs collaborating with others as percentage of total number of SMEs	Percentage	Regional Innovation Scoreboard	NUTS 2	2017	93%
EQI	The European Quality of Government Index (EQI)	z-score (-2.5 to 2.5)	The Quality of Government (QOG) Institute, University of Gothenburg	NUTS 2	2017	90%
WGI Index	Average index score based on six dimensions of governance: voice and accountability, political stability and absence of violence and terrorism, government effectiveness, regulatory quality, rule of law and control of corruption	Score (-2.5 to 2.5) in standard deviation from EU-average	The World Bank Group	Country	2016	100%
Poverty and social exclusion	Percentage of the people at risk of poverty or social exclusion	Percentage	Eurostat [ilc_peps11]	NUTS 2	2016	72%
Harbour						
Sustainable Cities Index	Sustainable Cities Index score	Percentage	Arcadis Sustainable Cities Index	City	2016	79%
Cities in Motion Index	Cities in Motion Index score	Score	IESE Business School	City	2016	93%
Smart Cities Index	Smart Cities Index score	Score (1-10)	EasyPark Group	City	2017	86%
Regional green economic performance	Composite index of Green Economy Theoretical Potentials	Score	ESPON	NUTS 2	2010	93%
Green urban areas	Share of green urban areas and forests as a percentage of total land area	Percentage	Copernicus Urban Atlas Data	City	2012	93%
University ranking	Average number of a university's appearances in QS, Shanghai, Leiden and Times rankings	Score	Cultural and Creative Cities Monitor	City	2014	90%
Foreign-born population	Percentage of the total population which is foreign-born	Percentage	Eurostat [urb_percep]	City	2011 & 2014	76%
Tolerance of foreigners	Percentage of the population which strongly agrees with the statement: 'The presence of foreigners is good for this city'	Percentage	Eurostat [urb_percep]	City	2015	72%
Integration of foreigners	Percentage of the population which strongly agrees with the statement: 'Foreigners who live in this city are well integrated'	Percentage	Eurostat [urb_percep]	City	2015	76%

Human rights	Country ranking on a scale between 0% (gross violations of human rights, discrimination) and 100% (respect for human rights, full equality)	Percentage	European Region of the International Lesbian, Gay, Bisexual, Trans & Intersex Association (ILGA-Europe)	Country	2016	100%
International co-publications	Average proportion of the publications of a university co-authored by two or more countries	Percentage	Leiden Ranking 2018	City	2013-2016	100%
Interpersonal trust	Percentage of the population that strongly agrees with the fact that most people in the city can be trusted	Percentage	Eurostat [urb_percep]	City	2015	76%
Memberships of transnational municipal networks	Number of memberships in ICLEI, C40, EUROCITIES, UNESCO Creative Cities Network and Sharing Cities Network	Score (0-5)	ICLEI, C40, EUROCITIES, UNESCO Creative Cities Network, Sharing Cities Network	City	2019	100%
International meetings	Number of international meetings per 100,000 city inhabitants	Score	International Congress and Convention Association (ICCA)	City	2016	97%
International cultural festivals	Number of cultural festivals hosted which have been awarded the EFFE quality label	Score	Festivalfinder.eu (EFFE)	City	1 Jan 2015 - 31 Dec 2019	100%
Venture capital	Availability of venture capital	Normalised score (0-1)	Regional Ecosystem Scoreboard	NUTS 2	2016	90%
Availability of funds from public sector	Includes direct loans by governments to SMEs and share of innovators receiving public financial support (as % of total innovators)	Normalised score (0-1)	Regional Ecosystem Scoreboard	NUTS 2	2016	90%
Structural Funds dedicated to entrepreneurship and SMEs	Percentage of all Structural funds in the region in the programming period 2007-2013	Normalised score (0-1)	Regional Ecosystem Scoreboard	NUTS 2	2016	90%
Additional indicators						
EQI	The European Quality of Government Index (EQI)	z-score (-2.5 to 2.5)	The Quality of Government (QOG) Institute, University of Gothenburg	NUTS 2	2017	90%
WGI Index	Average index score based on six dimensions of governance: voice and accountability, political stability and absence of violence and terrorism, government effectiveness, regulatory quality, rule of law and control of corruption	Score (-2.5 to 2.5) in standard deviation	The World Bank Group	Country	2016	100%

		from EU-average				
Poverty and social exclusion	Percentage of the people at risk of poverty or social exclusion	Percentage	Eurostat [ilc_peps11]	NUTS 2	2016	72%
Gross Domestic Product (GDP) per capita	Purchasing Power Standard (PPS) per inhabitant	Score	Eurostat [met_10r_3gdp]	Metro	2015	90%
Availability and accessibility of internet connections	Percentage of all private households with access to the internet at home	Percentage	Eurostat [isoc_r_iacc_h]	NUTS2	2016	97%
Discarded indicators						
Conferences	Number of conferences and academic events	Scale	Conal Conference Alerts	City	2019	100%
Film festivals	Number of film festivals	Scale	Filmfreeway	City	2019	100%
Fab City Network member	Member of Fab City Network	0 = no; 1 = yes	Fab City Global Initiative	City	2019	100%
Ozone concentration	Accumulated ozone concentration in excess 70 µg/m³	Percentage	Eurostat [urb_cenv]	City	2013	83%
NO concentration	Annual average concentration of NO2 (µg/m³)	Percentage	Eurostat [urb_cenv]	City	2013	90%
PM10 concentration	Annual average concentration of PM10 (µg/m³)	Percentage	Eurostat [urb_cenv]	City	2013	86%
Greentech clusters	Number of clusters specialised in green technologies per million inhabitants	Scale	ESPON	NUTS 2	2013	100%
Port city	Listed in top 20 EU ports in terms of gross weight of goods handled	0 = no; 1 = yes	Eurostat [mar_mg_aa_pwhd]	City	2016	100%
Broadband access	Percentage of all private households with access to broadband	Percentage	Eurostat [isoc_r_broad_h]	NUTS2	2016	93%

Appendix E: Descriptive statistics

Table E1. Pooled descriptive statistics (n = 29).

	Dependent variable	**Minimum**	**Maximum**	**Mean**	**S.D.**
	DEPVAR_1 (City)	0,11	10,92	3,73	2,83
	DEPVAR_2 (NUTS 2)	0,07	3,61	1,18	0,85
	DEPVAR_3 (NUTS 3)	0,07	7,37	1,82	1,39
	Indicators	**Minimum**	**Maximum**	**Mean**	**S.D.**
1	UI_COLLAB	0	10,20	5,64	2,23
2	AVERAGE_UNI	0	5,94	2,24	1,49
3	EMPLOY_HTECH	1,90	9,90	5,57	2,26
4	HTECH_PAT	1,01	152,50	26,70	31,53
5	ICT_PAT	1,46	198,38	36,72	42,49
6	CD_APP	3,17	147,61	43,79	31,24
7	RND_INTENSITY	0,85	4,78	2,16	1,07
8	TERTIARY_EDUC	15,20	57,10	38,64	10,23
9	LIFELONG_LEARNING	1,40	35,60	13,73	8,85
10	INTENT_COMM	0	13	2,48	3,33
11	HIPSTER	1,61	6,94	4,14	1,23
12	TT_INITIATIVES	0	4,45	1,05	1,39
13	COM_ACTION	1	14	4,17	3,29
14	CREA_JOBS	96,38	406,44	198,74	75,15
15	UNESCO_MEM	0	1	0,24	0,44
16	MAKERSPACES	0,50	33,29	11,03	8,52
17	COWORKING	0,20	10,75	3,20	2,37
18	FIRM_COLLAB	0,09	0,82	0,41	0,20
19	SUST_INDEX	45,90	74,60	64,33	6,64
20	CIM_INDEX	57,90	99,65	75,11	10,56
21	SMART_CITY_INDEX	3,90	8,20	6,13	1,27
22	GR_EC_PERF	0,50	1,46	0,94	0,21
23	GR_URB_AREAS	4,85	56,17	17,61	11,21
24	UNI_RANK	0,50	26,75	7,29	5,37
25	FOREIGN_BORN	0,10	44,40	23,57	8,98
26	TOL_FOREIGN	8	58	31,50	11,77
27	INTEG_FOREIGN	3	21	9,62	4,39
28	HUMAN_RIGHTS	8,60	78,76	50,70	20,60
29	INT_COPUB	0	67,60	54,57	12,86
30	INTERPERS_TRUST	2	32	12,06	7,84
31	TMNS	0	4	2,28	1,03
32	MEETINGS	0,22	26,97	8,24	6,79
33	CULT_FESTIVALS	0	38	9,97	8,96
34	VENTURE_CAPITAL	0,13	1	0,56	0,23
35	PUBLIC_FUNDS	0	0,66	0,18	0,19
36	STRUCTURAL_FUNDS	0,06	0,71	0,33	0,17
37	INTERNET_ACCESS	67	97	88,25	7,51
38	GDP_NUTS2	15600	58900	39265	10873
39	QOG_INDEX_2017	-1,88	1,44	0,17	1,05
40	WGI_INDEX	-0,70	1,77	1,02	0,68
41	POV_SOCEXCL	10,10	49,90	22,29	8,00

Appendix F: Top five indicators per city

Table F1. Overview of indicators in the top five best performance per city.

City	Indicators
Amsterdam	CD applications, Lifelong learning, Hipster culture, Makerspaces, Coworking spaces, Community action, Cities in Motion Index, Smart City Index, TMNs, International meetings, Structural funds dedicated to entrepreneurship and SMEs, Internet access, GDP per capita, WGI Index
Athens	International cultural festivals, TMNs, International meetings
Barcelona	Intentional communities, UNESCO Creative Cities Network member, Coworking spaces, University ranking, Human rights, TMNs, Availability of funds from public sector
Berlin	University-industry collaboration, ICT patent applications, R&D intensity, Intentional communities, UNESCO Creative Cities Network member, Smart City Index, Regional green economic performance, Green urban areas, TMNs, Availability of venture capital
Birmingham	Inter-firm collaboration, Human rights, Structural Funds dedicated to entrepreneurship and SMEs
Brussels	International cultural festivals, Inter-firm collaboration, Regional green economic performance, University ranking, Foreign-born population, Human rights, International co-publications, Availability of venture capital, Availability of funds from public sector, GDP
Bucharest	International cultural festivals, Tolerance of foreigners, Integration of foreigners
Cologne	None
Copenhagen	University-industry collaboration, High-tech patent applications, CD applications, R&D intensity, Tertiary education, Lifelong learning, Makerspaces, Coworking spaces, Transition town initiatives, Community action, Cities in Motion Index, Smart City Index, Tolerance of foreigners, Human rights, Interpersonal trust, TMNs, International meetings, Availability of venture capital, Structural funds dedicated to entrepreneurship and SMEs, EQI, WGI Index
Dublin	Universities per capita, Employment in high-tech sectors, Tertiary education, UNESCO Creative Cities Network member, Tolerance of foreigners, Integration of foreigners, Interpersonal trust, International co-publications, International meetings, GDP
Frankfurt	High-tech patent applications, ICT patent applications, Jobs in creative sector, Transition town initiatives, Sustainable Cities Index, Foreign-born population, Integration of foreigners, GDP, Poverty and social exclusion
Gothenburg	University-industry collaboration, Universities per capita, R&D intensity, Lifelong learning, Intentional communities, Regional green economic performance, Green urban areas, TMNs, EQI, WGI Index
Istanbul	UNESCO Creative Cities Network member, TMNs
Lisbon	Universities per capita, Hipster culture, Jobs in creative sectors, Coworking spaces, Transition town initiatives, Human Rights, TMNs, International meetings, International cultural festivals
London	Tertiary education, Inter-firm collaboration, Transition town initiatives, Sustainable Cities Index, Cities in Motion Index, University ranking, Foreign-born population, Tolerance of foreigners, Integration of foreigners, Human rights, Interpersonal trust, Internet access, GDP
Madrid	Employment in high-tech sectors, Intentional communities, Integration of foreigners, Human rights, Interpersonal trust, Availability of funds from public sector
Milan	Jobs in creative sectors, UNESCO Creative Cities Network member, University ranking
Moscow	None
Naples	None
Nijmegen	Universities per capita, Community action, Structural Funds dedicated to entrepreneurship and SMEs, Internet access, EQI, WGI Index
Paris	High-tech patent applications, ICT patent applications, CD applications, Tertiary education, Hipster culture, Jobs in creative sectors, Makerspaces, Transition town initiatives, Cities in Motion Index, University ranking, Availability of venture capital, Availability of funds from public sector, GDP
Prague	Employment in high-tech sectors, UNESCO Creative Cities Network member, TMNs, International cultural festivals, GDP, Poverty and social exclusion
Rome	UNESCO Creative Cities Network member, TMNs, Availability of venture capital
Rotterdam	University-industry collaboration, Makerspaces, Inter-firm collaboration, Community action, TMNs, Structural Funds dedicated to entrepreneurship and SMEs, Internet access, EQI, WGI Index
Stockholm	Employment in high-tech sectors, High-tech patent applications, ICT patent applications, CD applications, R&D intensity, Tertiary education, Lifelong learning, Intentional communities, Sustainable Cities Index, Smart City Index, Regional green economic performance, Green urban areas, Tolerance of foreigners, Interpersonal trust, International co-publications, TMNs, Internet access, EQI, WGI Index, Poverty and social exclusion
Thessalonica	None

Vienna	University-industry collaboration, R&D intensity, Inter-firm collaboration, Sustainable Cities Index, Regional green economic performance, University ranking, International co-publications, Availability of funds from public sector
Warsaw	Employment in high-tech sectors, CD applications, Tertiary education, Regional green economic performance, TMNs
Zurich	Universities per capita, High-tech patent applications, ICT patent applications, Tertiary education, Lifelong learning, Hipster culture, Jobs in creative sectors, Makerspaces, Coworking spaces, Sustainable Cities Index, Cities in Motion Index, Smart City Index, Regional green economic performance, Foreign-born population, International co-publications, GDP, WGI Index, Poverty and social exclusion

Appendix G: Correlation matrix

Table G1. Correlation matrix.

	DEPVAR_1	DEPVAR_2	DEPVAR_3	UI_COLLAB	AVERAGE_UNI	EMPLOY_HTECH	HTECH_PAT	ICT_PAT	CD_APP	RND_INTENSITY	TERTIARY_EDUC	ONG_LEARNING	INTENT_COMM	HIPSTER	TT_INITIATIVES	COM_ACTION	CREA_JOBS	UNESCO_MEM	MAKERSPACES	COWORKING	FIRM_COLLAB	SUST_INDEX	CIM_INDEX	SMART_CITY_INDEX	GR_EC_PERF	GR_URB_AREAS	UNI_RANK	FOREIGN_BORN	TOL_FOREIGN	INTEG_FOREIGN	HUMAN_RIGHTS	INT_COPUB	INTERPERS_TRUST	TMNS	MEETINGS	CULT_FESTIVALS	VENTURE_CAPITAL	PUBLIC_FUNDS	STRUCTURAL_FUNDS	INTERNET_ACCESS	GDP_NUTS2	GDP_NUTS3	QOG_INDEX_2017	WGI_INDEX
DEPVAR_1	1																																											
DEPVAR_2	,432*	1																																										
DEPVAR_3	,555**	,530**	1																																									
UI_COLLAB	,270	,361	,413*	1																																									
AVERAGE_UNI	,675**	,176	,170	,392*	1																																							
EMPLOY_HTECH	-,046	,430*	,019	-,046	,059	1																																						
HTECH_PAT	,168	,256	,284	,476**	,305	,284	1																																					
ICT_PAT	,248	,299	,311	,486**	,352	,270	,977**	1																																				
CD_APP	-,085	-,025	,118	,468**	,254	,245	,576**	,519**	1																																			
RND_INTENSITY	-,026	,207	,283	,719*	,168	,085	,549*	,528*	,463*	1																																		
TERTIARY_EDUC	,122	,472**	,223	,282	,283	,623**	,459*	,436*	,480**	,240	1																																		
LIFELONG_LEARNING	,228	,206	,110	,687**	,548**	,080	,638**	,683**	,537**	,598*	,468**	1																																	
INTENT_COMM	,054	,146	,112	,166	-,128	,019	,167	,145	-,065	,128	,148	,019	1																																
HIPSTER	,253	,132	-,002	,010	,347	,125	,232	,251	,304	,168	,273	,329	-,025	1																														
TT_INITIATIVES	,204	,196	,541**	,108	,095	,100	,216	,142	,289	,087	,339	,054	,053	,125	1																													
COM_ACTION	,104	-,132	,163	,116	,219	-,249	-,066	-,107	,180	,002	,067	,188	-,223	-,118	,189	1																												
CREA_JOBS	,372*	,220	,210	,072	,307	,205	,408*	,456*	,270	,120	,177	,406*	,016	,693**	,295	-,194	1																											
UNESCO_MEM	-,013	,168	,016	-,121	-,141	,212	-,178	-,172	-,156	-,084	-,279	-,341	,089	-,044	-,182	-,242	-,064	1																										
MAKERSPACES	,247	,303	,242	,505**	,378*	-,083	,241	,211	,460*	,222	,316	,521**	-,024	,322	,199	,511**	,269	-,169	1																									
COWORKING	,485**	,294	,290	,228	,467**	,119	,267	,253	,239	,060	,329	,379*	,086	,597*	,348	,118	,676**	-,103	,563**	1																								
FIRM_COLLAB	,053	,245	,174	,324	,100	-,108	,026	,018	,007	,099	,244	,223	-,260	-,110	,220	,295	-,126	-,110	,331	-,004	1																							
SUST_INDEX	,216	,435*	,408*	,490**	,252	,316	,519**	,527**	,387*	,367	,435*	,507**	,092	-,026	,236	,110	,261	-,237	,372	,276	,063	1																						
CIM_INDEX	,235	,532**	,465*	,541**	,313	,228	,485**	,440*	,548**	,285	,579**	,462**	,133	,151	,519**	,178	,305	-,097	,570**	,438*	,358	,687**	1																					
SMART_CITY_INDEX	,315	,411*	,415*	,697**	,352	,027	,615**	,603**	,426*	,514*	,383*	,663**	,217	,204	,284	,138	,353	-,013	,481**	,385*	,351	,519	,738**	1																				
GR_EC_PERF	,240	,586**	,397	,644**	,269	,131	,412*	,412*	,212	,536**	,448*	,413*	,319	,224	,163	,117	,103	-,093	,443*	,286	,308	,280	,454	,512*	1																			
GR_URB_AREAS	,007	,294	,045	,421*	,166	,214	,680**	,725**	,308	,565**	,345	,538**	,257	,131	-,153	-,299	,122	-,090	-,082	-,013	-,097	,306	,132	,359	,426*	1																		
UNI_RANK	-,008	,241	,102	,180	,073	,229	,304	,262	,425*	-,031	,370*	,216	,168	,115	,528**	-,013	,263	,088	,206	,148	,311	,318	,676**	,417*	,163	,022	1																	
FOREIGN_BORN	,133	,270	,321	,260	-,085	-,098	,221	,270	,064	,009	,099	,271	-,017	-,018	,271	,029	,269	-,212	,332	,102	,386	,287	,304	,285	,139	,027	,300	1																
TOL_FOREIGN	,299	,214	,311	,271	,268	,242	,593**	,566**	,261	,285	,421*	,400*	,167	,156	,288	,060	,285	-,164	,058	,324	-,120	,421*	,424*	,534**	,177	,239	,178	,023	1															
INTEG_FOREIGN	,119	,005	,212	-,266	-,188	,088	-,134	-,128	-,109	-,345	,173	-,231	,114	-,106	,403*	,074	,022	-,051	-,249	-,054	-,078	,055	,147	,033	-,238	-,279	,274	,237	,432*	1													
HUMAN_RIGHTS	,337	,338	,400*	,560**	,353	-,008	,306	,238	,224	,257	,407*	,313	,288	-,009	,589**	,215	,091	-,341	,460*	,468**	,433*	,405*	,642**	,537**	,573*	,070	,356	,249	,280	,042	1											
INT_COPUB	,409*	,373*	,332	,679**	,491**	,011	,418*	,428*	,325	,338	,348	,536**	,101	,087	,259	-,012	,210	-,119	,368*	,357	,434	,305	,548**	,520**	,500*	,263	,364	,288	,159	-,255	,562**	1										
INTERPERS_TRUST	,278	,223	,220	,477**	,305	,136	,584**	,556**	,245	,343	,437*	,562**	,387*	,008	,193	,043	,157	-,158	,186	,227	,043	,457*	,492**	,614**	,244	,314	,290	,219	,792**	,279	,374	,413*	1									
TMNS	,017	,100	-,168	,192	,249	,052	,035	,008	,145	,206	,140	,275	,230	,414*	-,032	-,038	,179	,244	,321	,403*	,029	-,176	,004	,067	,338	,235	,109	-,250	-,301	-,569**	,102	,282	-,081	1								
MEETINGS	,495**	,254	,206	,267	,674**	,181	,185	,153	,135	,128	,316	,325	-,097	,476*	,211	,131	,368*	-,002	,446*	,802**	,056	,112	,289	,295	,298	-,063	-,016	-,095	,329	-,155	,400*	,395*	,247	,404*	1							
CULT_FESTIVALS	-,124	,195	-,108	-,287	,004	,297	-,188	-,237	-,129	-,271	,165	-,368*	-,145	,165	,031	-,131	-,086	,140	,082	,085	,071	-,285	-,108	-,379	,135	-,118	-,029	-,054	-,345	-,157	,018	-,177	-,388*	,314	,260	1						
VENTURE_CAPITAL	,025	,202	,202	,340	-,043	,255	,391*	,343	,428*	,366	,195	,228	,058	-,237	,106	,042	,004	,101	,157	-,023	-,025	,263	,289	,381	,086	,231	,016	,054	,253	-,055	,194	,228	,255	-,144	-,062	-,296	1					
PUBLIC_FUNDS	-,054	,050	-,059	-,076	,010	-,006	,003	-,022	,153	-,065	,008	,013	,115	,138	,163	,144	,200	-,017	,253	,142	,197	-,068	,120	,047	,068	-,297	-,142	,146	,153	-,199	,178	,289	-,297	-,142	,146	,153	-,199	,129	-,021	,048	,097	1		
STRUCTURAL_FUNDS	,151	-,283	,046	,367	,101	-,421	,009	,018	,086	,154	-,138	,409	,105	-,042	-,037	,230	,061	-,209	,211	,068	,127	,049	,056	,331	-,139	-,143	-,030	,116	,172	-,021	,111	,285	,371	,029	,005	-,598**	,132	-,146	1		
INTERNET_ACCESS	,102	,252	,294	,490**	,103	,180	,468**	,485**	,452*	,531**	,449*	,634**	,057	,207	,230	,395*	,280	-,150	,401*	,199	,350	,447*	,405*	,576**	,470**	,368*	,253	,292	,328	,087	,302	,220	,316	,088	,003	-,304	,314	,072	,261	1		
GDP_NUTS2	-,039	,396*	,343	,247	,034	,602**	,452*	,412*	,567**	,295	,669**	,302	-,121	,230	,412*	,135	,268	,009	,276	,256	,212	,394*	,515**	,350	,324	,253	,378*	,372*	,306	,232	,214	,253	,233	-,008	,210	,202	,336	,190	-,239	,563**	1		
GDP_NUTS3	,083	,168	,511**	,190	,022	,354	,441*	,408*	,672**	,223	,446*	,160	-,160	,252	,466**	,152	,342	-,048	,235	,264	,043	,326	,475*	,318	,165	,102	,315	,311	,266	,260	,149	,184	,078	-,188	,134	,021	,370	,167	-,148	,417*	,820	1	
QOG_INDEX_2017	,265	,257	,410*	,702**	,308	,053	,491**	,488**	,468*	,544*	,480*	,641**	,074	,139	,314	,333	,181	-,217	,350	,322	,423*	,393	,515**	,687**	,549**	,356	,278	,166	,467*	,051	,539*	,563**	,448*	,098	,266	-,370	,309	-,058	,395	,790**	,471**	,403*	1	
WGI_INDEX	,473**	,502**	,526**	,748**	,480**	,154	,470**	,480**	,378*	,482	,440*	,626**	,027	-,002	,302	,342	,181	-,234	,532**	,459*	,318	,714**	,668**	,675**	,555	,328	,191	,247	,406*	-,026	,704**	,524**	,431*	,021	,380*	-,243	,391	-,044	,204	,623**	,389*	,312	,742	1
POV_SOCEXCL	-,297	-,234	-,329	-,389*	-,339	-,285	-,375*	-,403*	-,475*	-,399*	-,488**	-,479**	-,111	-,414*	-,203	-,172	-,436*	-,094	-,280	-,400*	-,222	-,267	-,369	-,486*	-,410*	-,350	-,166	-,013	-,240	,003	-,245	-,371	-,219	-,308	-,235	,140	-,241	-,166	-,134	-,712**	-,542**	-,475*	-,663**	-,469**