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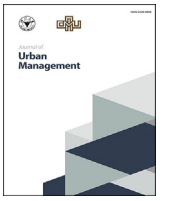

Research Article

City love and neighbourhood resilience in the urban fabric: A microcosmic urbanometric analysis of Rotterdam

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ABSTRACT

Ups and downs in city life are dependent on the citizens' appreciation for their urban 'home', in particular the neighbourhood liveability. Taking modern research on urban wellbeing and happiness as a point of departure, this study presents and tests a new methodology for assessing the residents' affection for their local neighbourhood. This approach is inspired by the 'city love' concept and seeks to examine and decompose city love through an analytical distinction into the 'body and soul' of the city. Using a rich multi-period and geographically detailed database on neighbourhoods in the city of Rotterdam, including distinct social capital indicators for analysing social resilience in urban areas, a microcosmic decomposition of objective and subjective socio-economic information is carried out. On the basis of geo-science visualisation methods and advanced spatial-econometric techniques for handling neighbourhood autocorrelation effects ('urbanometrics'), a series of explanatory regression analyses is executed in order to identify and explain the determinants of city love at neighbourhood level in Rotterdam. We find that bonding and bridging social capital are prominent in shaping neighbourhood love and social resilience.

1. The urban arena in motion

Urban areas (including cities) are complex multi-actor organisms that evolve in space and time. They comprise a wealth of tangible and intangible capital assets which may exhibit both slow and fast motion (Andersson & Andersson, 2017). The prediction and control of such dynamic urban entities is fraught with many problems, mainly due to lack of evidence-based understanding of the sometimes fragile nature and chaotic pattern of micro-units in a city (both districts/neighbourhoods and groups of social actors). In particular, disruptive events (e.g., natural disasters, pandemics, economic crises) may cause structural or temporal perturbations of various kind (Borsekova & Nijkamp, 2020), while an actionable recovery and a systemic resilience of urban systems operating under change or shock conditions is not guaranteed a priori (see Dziecielski et al., 2021).

An urban system contains not only material aspects (e.g. built environment), but also immaterial aspects (e.g. urban ambiance) as well as urban morphological aspects (e.g. form and structure). Despite much variety in these aspects, any urban system is generally characterised by a close proximity and high density - in different forms - among citizens and/or economic activities (Glaeser et al.,

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2021). Such geographical features may induce and exhibit various agglomeration externalities, such as interactive, economic, social, institutional, technological or cognitive externalities (see e.g. Caragliu, 2015). As mentioned, urban constellations are not static in nature, but are shaped by dynamic and interactive behaviour of micro-units, such as population groups, corporate business or urban districts. Micro-units refer here to spatially disaggregated groups or sub-groups of actors in a city. Of course, such (sub-) groups may geographically be located in specific locations in the city. Such a microcosmic perspective on urban life – inspired by a systemic decomposition – calls for a thorough analysis of small-scale units in a city based on an individual or place-based perspective (a so-called decomposition analysis; see Kourtit, 2021). Microcosmic refers to a methodological decomposition of an aggregate system into individual components at the lowest possible level which in an interconnected form add up to the system as a whole. An interesting contribution to a better understanding of the microeconomic behaviour of actors' interactions in a complex city can be found in Martinez Concha (2018), who positioned citizens and actors in the centre of the interactive and dynamic urban fabric. Another noteworthy contribution can be found in Lai (2021), who merged urban complexity theory and urban planning theory so as to properly understand dynamic interconnectivity in the ever-changing urban space which is difficult to manage.

Modern cities display indeed a complex arena with multiple actors, diverse interests and different morphological structures (Batty, 2005; Haas & Westlund, 2018). A city has a multi-faceted configuration that can be envisaged from different angles, e.g. geographical, economic, social, demographic, political or technological. In all cases however, a full understanding of the operating mechanism of a city requires reliable and up-to-date data, based on an appropriate spatial scale (e.g., urban district, neighbourhood, street level). This has led to the rise of an urban data-discipline, called urban informatics (see for a rather comprehensive introduction and overview, Shi et al., 2021). Urban informatics comprises and studies typical urban data of all kind (ranging from statistical data to social media data) that maps out the complex spatial pattern and evolution of a city (Bettencourt, 2021; Couclelis, 2021; Komninos & Kakderi, 2019). It has over the past decades inspired a wealth of evidence-based data-analytic studies on cities, using also quantitative methods and approaches like geoscience, space syntax, BIM models, digital twin analysis, microsimulation models, urban econometrics, spatial dashboard analysis, urban sensing and so forth. Such quantitative techniques are necessary test vehicles for new advances in urban theory and planning may act as decision-support tools for evidence-based urban planning from a microcosmic perspective. This approach calls for a decomposition of the urban space into relevant interdependent spatial units, such as urban districts, neighbourhoods, land use types, or population groups (Kourtit, 2021). Consequently, such a decomposed representation of a city leads to a multi-layer mapping of the urban fabric (see Shi et al., 2021). This new analytical approach based on a merger of data-analytics and spatial econometrics in the city will be called here 'urbanometrics'.

Cities are indeed interconnected social and ecological settlement systems, with a relatively high density of buildings and people so as to exploit the benefits from geographical proximity and agglomeration. They offer a shared and geographically concentrated habitat for people, communities and business, characterised by a high degree of socio-economic, cultural, political and technological diversity. From this perspective, liveable cities have become in recent years an important signpost for realising the UN New Urban Agenda. Clearly, urban land use, urban morphology and urban ambiance do in general contribute to the well-being of citizens in districts and neighbourhoods, while social capital and strong social bonds may make cities and their communities socially rather resilient in case of uncertainties and shocks. In the past years, concepts like citizens' well-being, urban quality of life, environmental contentment, urban happiness and urban love have become rather popular (see e.g. Kourtit et al., 2020; Kourtit et al., 2021; Wahlstrom et al., 2020; Östh et al., 2020). In the present study we will in particular zoom in on '*city love*' as a novel analytical concept reflecting the citizens' appreciation for their daily urban environment, comprising both tangible or material aspects (e.g., built environment, infrastructure, urban green) and immaterial and emotional/perceptional dimensions of urban life (e.g., urban identity, historical meaning, urban social climate, perceived architectural design). These two main constituents of urban life will be called here respectively 'body' and 'soul' of a city.

We will in our study conceptualise the notion of an urban body and soul, and operationalise these two concepts by means of various empirical indicators. In our microcosmic perspective on cities we will in particular analyse the question whether a micro-oriented systems approach to city life (neighbourhoods or communities) will allow to examine the neighbourhood or social resilience capacity of communities or residential groups in urban districts or neighbourhoods. Especially in case of socioeconomic or political uncertainty in a city social spatial resilience may be an effective tool in coping with a drastic change or decline so as to explore and design a recovery trajectory for a multi-layer urban system under threat.

City love is not a vaguely used term, but can be measured through appropriate numerical indicators, which stem from the appreciation, contentment or satisfaction derived by citizens from the use of or access to urban services (related to both the 'body' and the 'soul' of a city). The aim of the present paper is now to design and test a new methodology for operationalising the citizens' appreciation for the city ('city love') on the basis of two urban components ('body' and 'soul' of the city), with the final goal to explore whether a microcosmic approach to city life and city love leads to a better understanding of the neighbourhood or social resilience potential of the complex urban fabric. To that end, we will develop an operational microcosmic multivariate model – inspired by 'urbanometrics' – for mapping out the interactive forces in the city. Our testcase will be the city of Rotterdam, which over the past decades has shown a high dynamics and which has an extensive spatially disaggregated database on many indicators that are characteristic for urban well-being ('city love').

The paper is organised as follows. After this introductory section which sketches the contours of our study, we will further introduce in Sections 2 and 3, respectively, the concepts of city love and neighbourhood resilience. Next, Section 4 will be devoted to a description of the case of Rotterdam and of the data to be employed in our microcosmic analysis at district and neighbourhood level. This section will also provide a presentation of the multivariate 'city love' model developed for the city of Rotterdam. Next, Section 5 provides a description of the statistical and econometric results. An interpretation of our findings and policy conclusions are offered in Section 6.

2. City love as an offspring of urban happiness research

The past decades have shown a mounting interest in a quantification of quality of life, liveability, well-being, community contentment or social satisfaction. The availability of disaggregated – and often individual – information and data, combined with a rise in computing power, has prompted quantitative behavioural, experimental and attitudinal analyses of preferences and perceptions of people. Major breakthroughs have been achieved in experimental or behavioural psychometric studies (Kahneman, 2011; Kahneman & Krueger, 2006) and in quantitative sociological studies (Veenhoven, 2000; 2018). Research in economics has been more focused on well-being and happiness determinants (Easterlin, 2002; see for an informed overview; Frey, 2018), while in geography and regional science happiness research dates back to the beginning of this century (see for an introduction and overview Ballas, 2018).

In general, happiness research aims to identify in a quantitative sense the determinants of human happiness. Clearly, a wide variety of factors shaping happiness can be distinguished, ranging from individual features to contextual (environmental) factors (see for an illustration Fig. 1). We note that the 9 domains and 33 indicators of the Gross National Happiness (GNH) index are rather comprehensive, but several indicators are hard to measure, so that for comparative empirical purposes this scheme is less operational.

We also note that in recent years, applied urban happiness research has become a popular research topic (see e.g., Delmelle & Thill, 2014; Sassen & Kourtit, 2021; Morrison, 2021; Osth et al., 2020; Wahlstrom et al., 2020). Urban happiness research may be based on urban statistical data, survey methods or social media information, including experimental methods such as contingency analysis. In general, happiness refers to a state of mind of a person characterised by pleasure, contentment or enjoyment as a result of internal or external factors.

Clearly, in the geography of happiness the question is often asked: where do we find the most happy people? (see e.g. Florida et al., 2013). This valid research question seeks to identify the importance of geographical moderator variables on the happiness feelings of citizens (see e.g. Ballas & Tranmer, 2012; Neira et al., 2018; Burger et al., 2020; De Neve & Krekel, 2020; Morrison, 2020, 2021). An important finding from empirical research is that in the US medium-sized cities house more happy people than smaller cities or very large cities (see also similar results for the Netherlands obtained by Marlet and van Woerkens (2017) in their Happiness Atlas). However, happiness is not necessarily a relational variable in the context of the geography of a city. Contrarily, 'love' is a relational variable and expresses how much a given person or a given object means to the loving person. The feelings of satisfaction or attachment emerge from an emotional or perceptional appreciation for the subject or object being loved. From this perspective, we introduce and use the notion of 'city love' to examine the place-based features of a locality that shape the attachment of citizens or communities with respect to their neighbourhood or living environment. Such determinants may range from green urban areas (e.g. parks) or sports facilities to fewer

Fig. 1. A GNH (Gross National Happiness) index circle
Source: Ura et al. (2012).

tangible factors such as group identity or beauty of a neighbourhood. Clearly, the above-mentioned distinction between the 'body' and the 'soul' of a city in relation to the 'city love' concept is meaningful in this context, as has been demonstrated in recent publications (see Wahlstrom et al., 2020). However, spatial interdependencies in the determinants of city love at a disaggregated intra-urban scale were as yet not explicitly taken into account. This challenging research issue will now be addressed in the context of an urbanometric framework.

City love has different spatial ranges varying from indoor satisfaction with someone's daily domestic living environment to the external urban environment like historical quarters or urban green, while access to social capital in the vicinity may also be an important relational determinant (Li & Zhang, 2021; Ram, 2017). As mentioned, city love is a value intensity expression for the relationship of citizens with their urban environment ranging from objects or features in the immediate neighbourhood vicinity to public or private amenities (tangible or intangible) or features in the urban area as a whole. For example, a resident may be fond of a specific park in his/her neighbourhood (a tangible asset) or may highly appreciate the feelings of freedom or health (an intangible experience) provided by urban green in general (Kowark, 2018).

The analytical challenge of the present study is to position city love (through the constituents of body and soul) in a measurable form in the framework of urban neighbourhood resilience, using an urbanometric framework. This research question will now be further unfolded from a conceptual and methodological perspective in Section 3.

3. Neighbourhood resilience and city love: conceptualization

As mentioned in Section 2, we will use the body and soul conceptualization of the city to examine the relationship between neighbourhood resilience and residents' perceptions of both material and immaterial urban amenities. Our point of departure is the city love conceptual model developed by Kourtit et al. (2022), illustrated in Fig. 2. According to this scheme, the citizens' appreciation for their city can be related to their perceptions of physical and functional amenities (the 'body' of the city) as well as their emotional experiences and social life (the 'soul' of the city).

In this paper, the aim is to design and test a new methodology for operationalising city love, with the final goal to explore whether this new concept will generate a better understanding of the social (or neighbourhood) resilience potential of the complex urban fabric. To meet this aim, we expand the model from Fig. 2 to also encompass neighbourhood social resilience. This is illustrated in Fig. 3 by a functional relationship between social resilience at the neighbourhood level and the neighbourhood love. In this expanded model neighbourhood love is not only assessing the residents' appreciation for the neighbourhood, but also the commitment and responsibility they feel for their neighbourhood. Similar to the model presented in Fig. 2, neighbourhood love is decomposed into perceptions of the

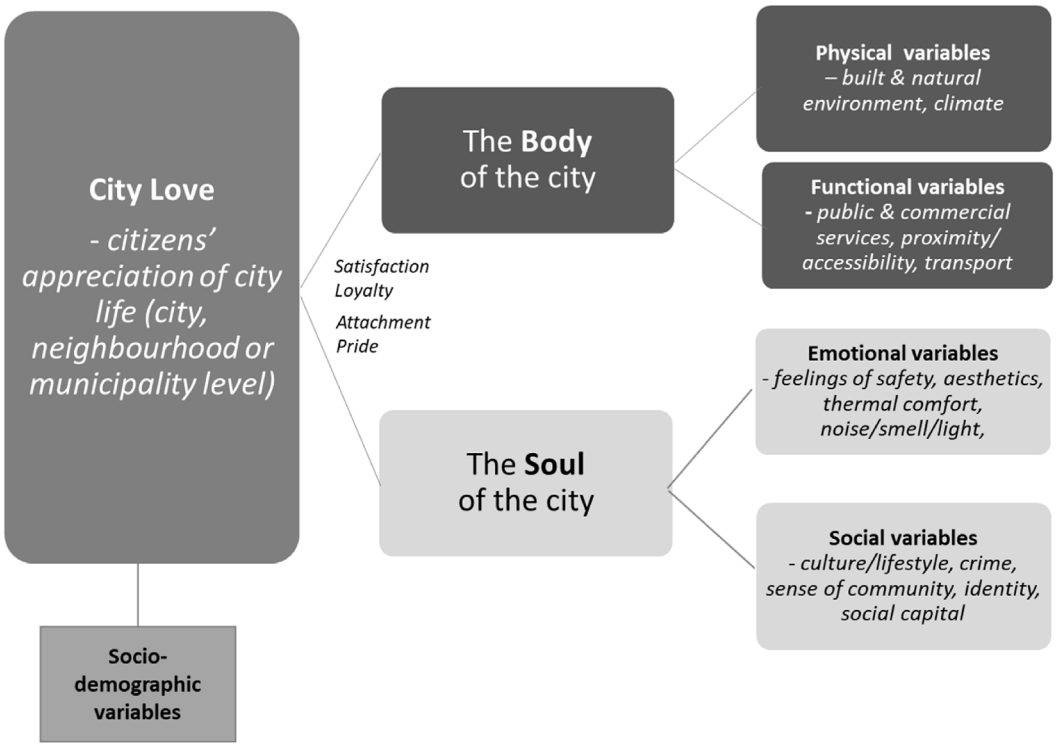

Fig. 2. The conceptual model of City Love, decomposed into the 'body' and 'soul' of the city (Kourtit et al., 2022).

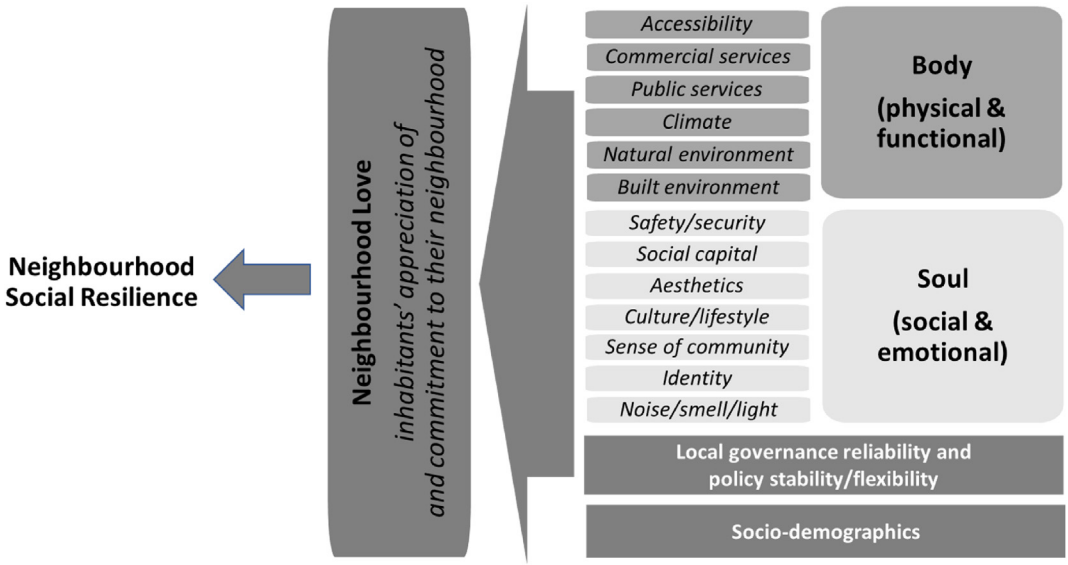

Fig. 3. The conceptual model of neighbourhood love and its relationship with neighbourhood social resilience.

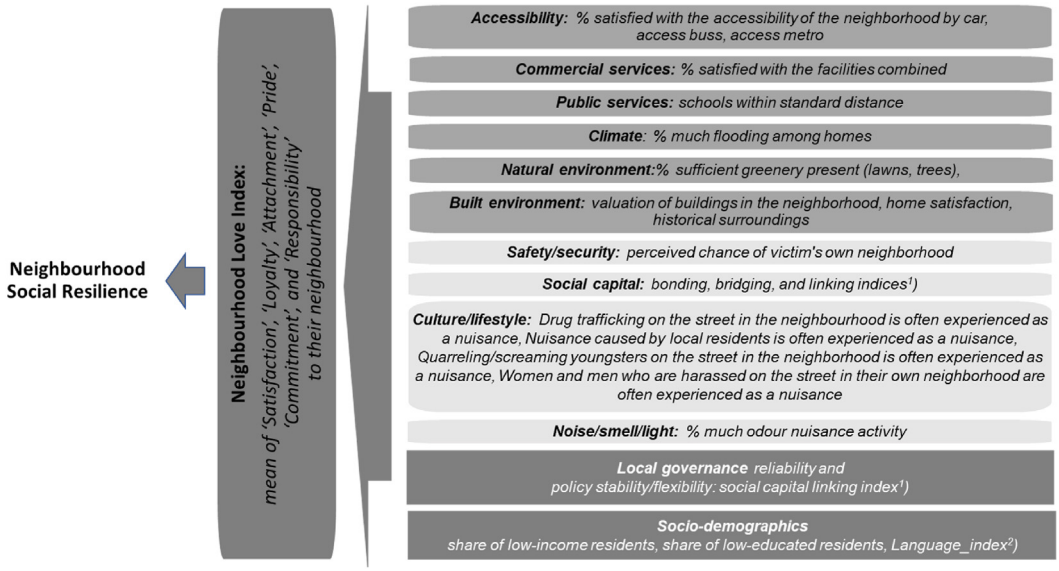

Fig. 4. Operationalising the conceptual model, using available data sources.

1) **Social capital network indices: Bonding:** (mean of) % of residents that say that neighborhood residents know each other, … spend a lot of time with eachother, …they have enough interest from others, …they know enough people to talk to, % residents with weekly neighbor contacts, …family contacts, …friend contacts, …contacts via the internet, % of residents that says they feel at home with local residents, … that says that neighborhood residents help each other, … that says that neighborhood residents share each other's views, … say they do not feel abandoned, and … that say they know enough people for help and advice

Bridging (mean of): % residents say that young and old interact well with each other in the neighborhood, …the interaction between ethnic groups in the neighborhood is good, … they do not experience discrimination in and outside their own neighborhood, % residents with weekly contacts with other neighbors,

Linking: (mean of) % residents say they have faith in government organizations, … the municipal council, … the municipal administration, % residents who are active in a residents' initiative, … have been involved in making plans for a neighborhood or city. As this index overlaps with the local governance reliability it will be used to operationalise local governance instead.

2) **Language index:** mean of % of residents say that they have difficulty speaking Dutch, % of residents say that they have difficulty reading Dutch, % of residents say that they have difficulty writing Dutch, % residents say they need language help.

neighbourhood's physical and functional features ('body') as well as social and emotional perceptions ('soul'). The reliability and stability of local governance, and the socio-demographic mix will also influence the neighbourhood love and thereby shape the social resilience of the neighbourhood.

The model illustrated in Fig. 3 implies that social capital might be an important ingredient in understanding social resilience on the local level. Social capital can be categorized in the following way (see also Adler & Kwon, 2002; Burt, 1997, 2000; Engbers et al., 2017; Granovetter, 1985, 2001; Healy et al., 2001; Poortinga, 2012; Portes, 1998, 2000; Putnam, 2000; Van Staveren & Knorringa, 2007; Woolcock and Narayan 2000):

- Bonding networks – people with the same social background engage with, trust and influence each other
- Bridging networks – people from different social backgrounds engage with, trust and influence each other
- Linking networks – people engage with, trust and influence organizations and systems in the society.

All these three networks are necessary for residents to believe that body and soul elements in urban life make a difference in society. Social sustainability is, together with love and respect for the community, an important aspect of individual resilience of citizens in their local environment. Love and respect are short-term feelings of attachment for a neighbourhood, where social sustainability refers to long-term balanced development of the social groups and networks in a city. Consequently, a solid social sustainability offers the foundation for a high individual and citizens' resilience. Such networks may cross, of course, neighbourhood borders and hence, there is a need for an urbanometric approach (see Section 4).

In the present paper, we have chosen the city of Rotterdam as our test base for analysing neighbourhood social resilience. In our empirical application, we use the Rotterdam Neighbourhood Data system and other public data bases for our statistical analyses (see Section 4 for a more detailed description of the available data). Fig. 4 outlines the operationalisation of the conceptual model sketched out before. This model forms the basis for application in Sections 4 and 5.

4. Data base and urban econometric ('Urbanometric') model

The city of Rotterdam has approx. 650.000 inhabitants. It has one of the biggest ports in the world. The city is split by a river and exhibits significant differences in socioeconomic well-being at district and neighbourhood level.

The Rotterdam Neighbourhood data system is very rich – containing survey and register data from 2014, 2016, 2018 and 2020 – about the quality of living and place-related experiences/perceptions of people in 14 city districts and 63 neighbourhoods in Rotterdam. Thus, the database contains both detailed statistical data on many place-based quality-of-life indicators and extensive survey data on the feelings and perceptions of the Rotterdam citizens. This makes the data very suitable for our body and soul analysis. The data from Rotterdam are statistically categorized into three major classes: The Safety, Social and Physical Index. The data contains both objective and subjective scores. The objective variables are typically register data or stated facts from the survey, while the subjective variables comprise surveyed preferences, attitudes, or individual valuations. The scores on the themes are then displayed as an index score, where the average score of Rotterdam has been set at 100 as the baseline measurement (2014). The scores of the 63 neighbourhoods are calculated in relation to this city average. The neighbourhood love model for Rotterdam will now be estimated using this detailed database.

The panel structure of the Rotterdam dataset allows us to explore how dynamic characteristics as well as body and soul functions of neighbourhoods can influence the local resilience patterns, as defined in our conceptual framework. Therefore, the analysis of neighbourhood resilience and city love requires an econometric regression framework that makes use of the temporal relationship between data points collected in two-year intervals from 2014 to 2020. Therefore, we specify the following baseline model:

$$NLI_{it} = \beta_i + \alpha P_{it} + \gamma S_{it} + \varepsilon_{it} \tag{1}$$

where NLI_{it} is the Neighbourhood Love Index (NLI) in neighbourhood i in year t, β_i represents neighbourhood fixed effects; P_{it} describes covariates for physical and functional dimensions (accessibility, public and commercial services etc.), while S_{it} indicates the social and emotional dimensions of neighbourhood, such as types of social capital accumulation, feelings of safety and satisfaction; while ε_{it} is an error term. We note that the error term might be spatially autocorrelated, which might lead to a regression model with spatially autoregressive disturbances. This forms the justification for our urbanometric approach.

We test for spatial autocorrelation by both Moran's I test and by means of the Lagrange multiplier test, in order to decide between the type of the spatial regression framework to be used (Anselin, 1996). Following the diagnostics, we estimate the following Spatial Error Panel Model (Elhorst, 2003):

$$NLI_{it} = \beta_i + \alpha P_{it} + \gamma S_{it} + u_{it} \tag{2}$$

$$u_{it} = \lambda \sum_{i \neq j} w_{ij} u_{it} + e_{it}$$

where u_{it} is a spatially autocorrelated error term, λ is the specific spatial term which measures spatial dependence, w_{ij} is a row standardized spatial weight matrix based on distances between i *and* j, while $\sum_{i \neq j} w_{ij} u_{it}$ is the spatial autoregressive specification, which captures spatial interactions in the urban area concerned. In the following section, we will report our statistical results and regression outputs. This basic urbanometric model will be estimated in Section 5.

5. Statistical results

Before presenting the spatial econometric results, we will first provide the outcomes of the spatial autocorrelation tests. The results of local spatial autocorrelation statistics on maps for each year of the survey data. Then, the correlation matrices between the NLI and a set of moderator variables are introduced based on our operational urbanometric model (based on Fig. 4). Next, we present the statistical-econometric outputs from the spatial error model of panel regressions.

Fig. 5 shows the local the spatial autocorrelation (LISA) statistics for 63 neighbourhoods in Rotterdam. The LISA estimates represent the similarity in the NLI among these neighbourhoods, where a light red colour indicates the clusters of high values, light blue the clusters of low values, while dark red colours show neighbourhoods with a high NLI surrounded by low NLI values. The maps show clearly concentration of high NLI in the Northern parts of the city; in particular, Hillegersberg Noord, Molenlaankwartier and Terbregge had consistently a high neighbourhood love over the years concerned. In 2018, the residents of Kralingse Bos, Kralingen Oost, 's-Gravenland and Kralingseveer reported also relatively high values of neighbourhood love, but two years later it returned to its previous levels. This area has shown an irregular evolution in recent years which may explain this fluctuation. Meanwhile, the Southern neighbourhoods of the city of Rotterdam show clusters of low neighbourhood love values, with the exception of Katendrecht, where we observe mixed high-low clusters. The latter area has a mix of old low-quality liveability conditions and modern high-standard quality of life, which explains the mixed result for this neighbourhood.

In addition, Fig. 6 includes the correlation matrices between the variables used in our analysis for each category of the survey data. The variables are selected based on the model framework introduced in the previous sections. In general, the correlation analysis

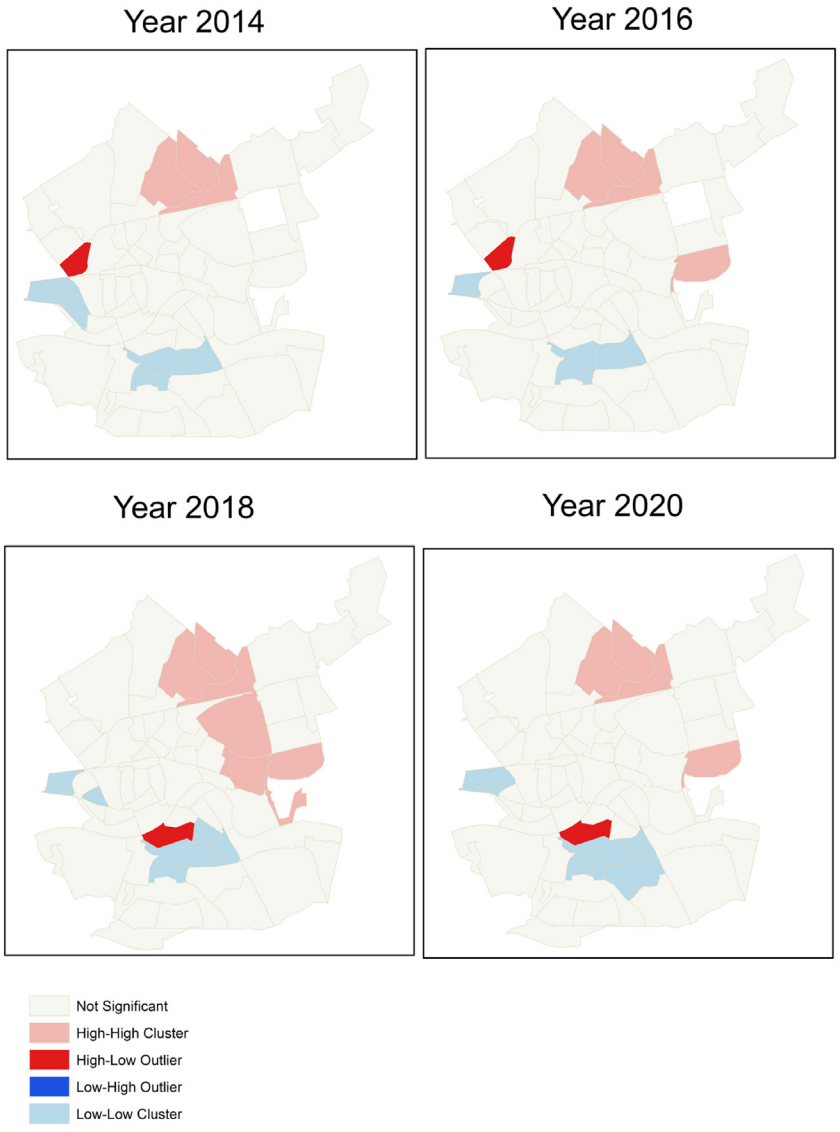

Fig. 5. Local autocorrelation Analysis of Neighbourhood Love Index in Rotterdam.

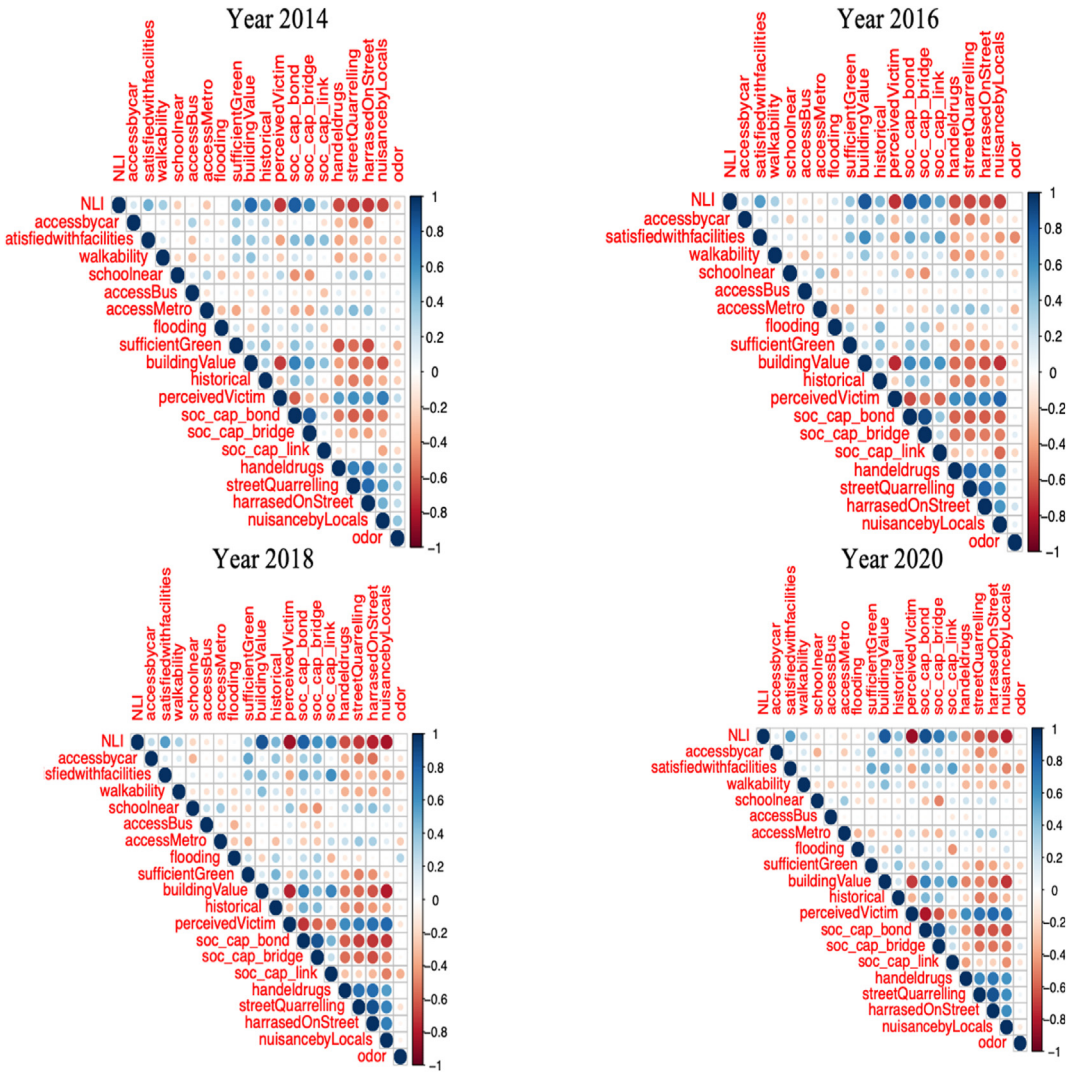

Fig. 6. Correlation analysis between the variables that illustrate the hypothesised relationship in the operational urbanometric model for Rotterdam.

supports our hypothesis on the relationship between the NLI on the one hand and body and soul functions of the neighbourhood on the other. In particular, accessibility of neighbourhood by car and by public transport and also walkability shows positive correlations with NLI. Similarly, the overall satisfaction with public and private facilities and with historical and natural amenities show a positive association with NLI.

Next, we tested the conceptual framework with bonding, bridging as well as linking types of social capital and safety-related variables for the social and emotional characteristics in the area. Again, we see similar correlations for each year, wherein bonding social capital shows the highest correlation with NLI, and a minor association observed for linking social capital. Meanwhile, exposure to drugs dealers on streets, frequent incidences of street quarrelling, the share of residents who experience harassment on streets and nuisance by locals show a consistently strong and negative association with NLI over the years under consideration.

Fig. 6 also illustrates a high correlation between the variables. To overcome potential multi-collinearity issues, we take the average of schools (at all levels) as a measure of public services and the average of homes within standard distances to shops and private medical services as a measure of commercial services. Natural surroundings are proxied by a subjective measure of appreciative green surroundings. The perceived potential of being a victim of criminal activity is used as the variable for safety/security. Finally, the satisfaction with home is a variable of the immediate built environment. Again, based on the same motivation, we run a separate model for each type of social capital, while the models control for the level of language difficulty and the share of low-income households.

Overall, the intra-urban spatial autocorrelations in Fig. 5 call for a spatial econometric (urbanometric) model with a correct specification, so that spatial processes can be disentangled. As mentioned before, we also test for global spatial autocorrelation and Lagrange multiplier tests for the final modelling framework. The global Moran's I test results appear to be significant and positive for all years,

with values ranging from 0.199 to 0.255. The diagnostics for spatial dependence based on a Lagrange Multiplier test show results in favour of a Spatial Error Model (Eq. (2)).

Table 1 summarises the regression outputs from spatial error models. The models are estimated by maximum likelihood estimators with neighbourhood fixed effects. Starting from the spatial processes, we see that the lambda coefficient is significant in all models, supporting our choice of spatial econometric techniques in urbanometrics. Positive coefficients indicate the presence of high-high and low-low clusters in the error terms; and therefore, if we would have used standard panel models, the estimates would be biased.

We find that the bonding and bridging social capital types predict higher neighbourhood love, hence social resilience. Hence, the income profiles of the neighbourhood become statistically insignificant, unlike in the model with linking type of social capital. We note that the relationship between social capital and resilience is well-known in the literature (Aldrich, 2011, 2012). In particular, bonding social capital has been shown to be strongly and positively correlated with community resilience (Lee, 2020). Our model supports the previous findings through our conceptual framing of social resilience by neighbourhood love. As in previous studies, linking social capital appears to have significant but relatively lower effects on social resilience (Poortinga 2012). Linking social capital is a measure of residents' perception of their reach to authorities. This means that while social resilience is a function of social capital, close ties and networks across heterogeneous neighbours appear to be more critical indicators of resilience than vertical networks. This points out the importance of open communication in neighbourhoods, as also indicated by the language index. The residents who experience language barriers have lower levels of integration, and less possibilities for communication and social capital building.

The remaining variables in the model specifications confirm our conceptual framework of social resilience. Public service accessibility is related to urban satisfaction, which in return helps to build more resilient communities. Perhaps surprisingly, accessibility of commercial services does not contribute substantially to NLI in Rotterdam. This might be related to negative externalities these services might bring to neighbourhoods, such as noise and pollution. We also find that green amenities are appreciated by the residents as a means toward building a more resilient community. The highest coefficient in the regression output is related to the safety and security perception of residents. The results indicate that negative concerns about safety cause residents to assess their neighbourhoods poorly. Meanwhile, satisfaction with own home shows a significant and positive influence.

Table 1
Results of spatial error model of panel data (Urbanometric Model) for Rotterdam.

VARIABLES	(1)	(2)	(3)
	Social Capital Bonding	Social Capital Bridging	Social Capital Linking
lowincome	−0.536	−0.954	−1.137*
	(0.626)	(0.607)	(0.625)
language_index	−0.113**	−0.180***	−0.141**
	(0.048)	(0.054)	(0.055)
soc_cap_bond	0.481***		
	(0.069)		
soc_cap_bridge		0.318***	
		(0.051)	
soc_cap_link			0.074***
			(0.009)
soc_cap_efficacy			
publicservices	0.028***	0.031***	0.006
	(0.010)	(0.009)	(0.009)
commercial	−0.002	0.003	−0.005
	(0.020)	(0.025)	(0.027)
sufficientgreen	0.035	0.044*	0.063**
	(0.024)	(0.026)	(0.030)
perceivedVictim	−5.354***	−6.995***	−6.647***
	(1.147)	(1.216)	(1.402)
homeSatisfaction	0.230***	0.266***	0.272***
	(0.039)	(0.036)	(0.039)
Spatial			
lambda	0.421***	0.367***	0.186*
	(0.100)	(0.106)	(0.102)
Variance			
ln_phi	0.262	0.454*	0.945***
	(0.240)	(0.256)	(0.258)
sigma2_e	4.427***	4.504***	4.139***
	(0.685)	(0.709)	(0.733)
Constant	29.165***	42.398***	54.845***
	(6.207)	(4.956)	(5.401)
Observations	252	252	252
R-squared	0.823	0.804	0.761
Number of id	63	63	63

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

6. Retrospect and prospect

Cities do not only exhibit a significant degree of socioeconomic heterogeneity (income, wealth, education) among urban districts and population groups, but also a considerable variation in well-being and happiness feelings. Taking the city of Rotterdam as an illustrative empirical learning case, the present study has sought to identify in which neighbourhoods' people can be found with a high degree of socioeconomic contentment. This research endeavour was inspired by the recently developed 'city love' concept – as part of the urban happiness literature – which was next decomposed into measurable 'body and soul' constituents of urban liveability. Thus, the main research focus was on the question: where and why do we find citizens with a high degree of appreciation for – or attachment to – their local neighbourhood? The city of Rotterdam has a well-documented, geographically detailed and multi-annual database (comprising both spatially disaggregate statistical information and individual citizens' survey data) which could be supplemented with open access data (e.g. from OpenStreetMap sources). Using an urbanometric approach, based on a combination of both modern geo-science images of the city and advanced spatial econometric modelling techniques (to take account of spatially correlated neighbourhood data), our multi-layer statistical analysis generated interesting findings for the city, from both a methodological and an applied policy perspective.

The spatial-econometric autocorrelation analysis at neighbourhood level appears to shed new light on the interwoven complexity of the urban system from a disaggregate perspective, which confirms our conceptual framework on the determinants of 'city love'. Not only is 'city love' of inhabitants shaped by the neighbourhood characteristics captured by the 'body and soul' features (including social capital characteristics), but also by 'body and soul' characteristics of adjacent neighbourhoods or districts. Consequently, our approach has demonstrated that the city is a complex socioeconomic fabric whose compartments are interlinked and shape in mutual combination the conditions for urban social resilience.

The design and application of models for capturing spatially interdependent socioeconomic phenomena in cities at district or neighbourhood levels has prompted the design of new modelling analytics, termed 'urbanometrics'. This is an amalgam of detailed and interactive urban systems modelling and spatial econometrics and is an offspring of the 'new science of cities' advocated by Batty (2013) and of urban informatics (Shi et al., 2021). The present study forms an operational illustration of the validity of urbanometric modelling, which forms the operational 'arm' of an urban microcosmic approach.

In the present empirical application of an urbanometric model, human interactions in the form of social neighbourhood capital appear to play a critical role in inducing social neighbourhood resilience in which both material/tangible and social/intangible dimensions are key. In addition, neighbourhood confidence in local governance and the presence of local government stability and flexibility appears to be a sine qua non for broadly shared city love.

From an operational and policy perspective, our results show that feelings of city love and social resilience at neighbourhood level (in particular, city love, social commitment and neighbourhood responsibility) are critically dependent on citizens' perceptions on local liveability, in particular, personal neighbourhood affection, safety/security, good access to schools and to public amenities and services, satisfaction with the own home, and broader social (bonding and bridging) capital in the neighbourhood.

It is noteworthy that our empirical results point at a prominent role of (i) bonding social capital, which suggests that citizens in a neighbourhood community with the same social background exhibit mutual trust and build up mutual support and interaction systems, and (ii) bridging social capital, which suggests that people in a local neighbourhood context with different social backgrounds also enjoy mutual trust and social communication and interaction. It should be added however, that language barriers and low local language proficiency are among the factors that cause socioeconomic heterogeneity and social isolation, and hence lead to lower social neighbourhood resilience.

Finally, we observe that access to commercial services (e.g., shops, bars, restaurants) appears to play a minor role in shaping a high NLI. This finding may also be caused by the mixed character of commercial services (e.g. repair shops for cars, pharmacies, local retail shops), while, in addition, the presence of such services may also cause various negative neighbourhood externalities (e.g. noise, pollution, parking annoyance). This issue calls certainly for more thorough research in the future.

In conclusion, the present study on city love at neighbourhood scale has made an operational attempt to map out the multi-scale complexity of an urban system through the use of a novel 'urbanometric' approach. The analysis of the city of Rotterdam has offered promising results, but calls for more empirical test experiments on theory and methodology for other cities in the world.

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