THE SOCIO-CULTURAL SOURCES OF URBAN BUZZ

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Abstract

Cities have become playgrounds for competitive behaviour and rapid economic dynamics. However, in many cities (or urban agglomerations), economic growth is mainly manifested in specific geographic areas, where creative people and innovative entrepreneurs are located. This paper offers first the conceptual and operational foundation for analysing this so-called 'urban buzz' and its interlinked primary drivers. The paper next develops an analytical framework for testing the buzz hypothesis, with a special reference to the importance of social bonds and networks in Amsterdam. In our empirical analysis, we use a unique data set on social network connectivity and spatial concentration in a city, based on location-sharing services through the use of Foursquare data. Our urban buzz model shows clearly that buzz and socio-economic (cultural) diversity are closely connected phenomena.

Keywords: cultural diversity, urban buzz, agglomeration, creativity, piazza, spatial dependence, social networks

1.   The Urban Stage

In the past decades, the awareness has grown that cities have become epicentres of socio-economic dynamism. New knowledge, innovations, creative lifestyles and entrepreneurial heroism often find their genesis in urban agglomerations. The rising importance of the 'urban magnetism' is clearly demonstrated in the ever-increasing urbanization rates worldwide. Clearly, there are examples of shrinking cities (such as Detroit or Leipzig), but the loss in their urban population is overshadowed by the rise in urbanization elsewhere. The urbanized way of living – not necessarily in compact city centres, but more broadly in urban agglomerations including satellite towns and edge cities – has gradually become a dominant megatrend in our world. In several recent publications, Kourtit and Nijkamp (2013a,b,c) offer considerable evidence of the emerging 'urban century', which they coined the '*New Urban World*'.

It should be noted however, that the '*New Urban World*' does not display a uniform settlement pattern. On the contrary, it is characterized by great diversity in living and working patterns, in urban land use and architecture and in urban management and governing institutions. There is an abundance of literature that traces the roots of rising urbanization. These are mainly sought in the presence of spatial externalities (often in the form of so-called MAR – Marshall–Arrow–Romer – externalities dealing with various economies of scale in urban areas) and social capital benefits (often referred to as 'melting pot' advantages in the spirit of Jane Jacobs). Extensive treatments of these issues can be found in Nijkamp (2008) and van der Ploeg and Poelhekke (2008).

The variety of scholarly contributions on the advantages of urban areas can essentially be subsumed under the heading of three driving forces, viz. economies of *density*, economies of *proximity* and economies of *connectivity*. The first category focuses essentially on the joint advantages of the spatial concentration of people and activities (see e.g. Glaeser et al. 1992; Nijkamp 2008). The next class addresses the benefits of physical or socio-psychological access of people and activities to each other (see e.g. Boschma 2005; Torre and Gilly 2005; Tranos et al. 2013). The final category concerns the economies generated in a city that emerge from social capital or network linkages – physical or virtual – among heterogeneous groups of people and activities (see Sahin et al. 2007), be they at a short distance or at a long distance (see Tranos et al. 2013).

These classes of external economies explain the booming character of modern cities, in contrast to small towns, villages or rural areas. This does not mean that the latter areas have no socio-economic prospect (see e.g. Noronha Vaz et al. 2013), but in general the socio-economic future of our world tends to be determined by areas with a high degree of urbanization, as such areas generate a wealth of unrivalled centripetal and centrifugal forces and associated benefits. One of the resulting dynamic urban constellations to be frequently mentioned in the current literature on urbanization advantages is 'urban

buzz', which refers to the joint potential to generate creative, innovative and unconventional initiatives or activities in cities or specific urban districts. In the next section, we will offer a concise introduction to this urban buzz concept. The aim of the paper is to investigate whether and to what extent the above-mentioned economies of density, proximity and connectivity offer a significant contribution to the emergence of urban buzz. The paper will address in particular the impact of socio-economic diversity – including cultural diversity – as an intervening factor in favouring urban buzz. This conceptual model will next be operationalized and empirically tested in a case study on Amsterdam. An extensive database from the Foursquare location-sharing service will be employed to estimate econometrically the 'urban buzz equation' as a social bond phenomenon in the city.

2.   Urban Buzz

The phenomenon of urban buzz has to be seen against the background of business dynamics and innovation in urban areas. Innovative firms are change agents in a creative urban 'milieu'. The economic performance of business enterprises depends on both the firms' indigenous capabilities and the supply of resources in their flanking environment (see e.g. Barney 1991; Nijkamp and Kourtit 2011, p. 16; Kourtit and Nijkamp 2012; Kramer and Diez 2012). Clearly, the growth of companies will be constrained if there is a shortage or weakness in the available resources or in the capability to mobilize or generate adequate resources (Nijkamp 2008, p. 10; Nijkamp 2010, p. 88). Reid and Garnsey (1998) distinguish between different stages of growth, ranging from the achievement of access to resources to the mobilization of resources, and the companies' own generation of resources. The use of the right combination of resources at the right time by young, innovative entrepreneurs enables them to undertake a jump in growth (Kourtit and Nijkamp 2012). Failing to use the right combination at the right time may cause a delay in growth and even a fall back into previous stages (Vohora et al. 2004). In the early growth stages and after a fall back to such stages, firms rely heavily on the resources available in the direct environment or proximity, including the urban environment and its constituent infrastructure and suprastructure (Nijkamp 2010, p. 88) .

Cities offer in many cases the creative network conditions for acquiring new knowledge and expertise. In recent years, the resource-based growth perspective has clearly extended its scope from physical resources to human and social capital resources (Nijkamp 2008, p. 10; Nijkamp and Kourtit 2011, p. 16). It is nowadays broadly accepted that regions and cities – and sometimes urban districts in a Marshallian sense – may use their indigenous resources and may offer unique geographic and location conditions and facilities, beyond other competitive assets, to attract talents and firms to (relatively less favoured) regions in the belief that they generate (more) positive externalities. In turn, this may bring

about positive socio-economic achievements, which may enhance the territorial competitive advantages. As a result, over the past decades, cities – and their creative districts – all over the world have managed to reinforce their socio-economic position, albeit sometimes with up and downs. This brings us to the notion of urban buzz.

Urban buzz – as a result of density, proximity and connectivity externalities – has received quite an amount of attention in the recent urban literature. Buzz areas – be they cities as a whole or urban districts – are powerhouses of innovation, creativity and unconventional lifestyles. In a study by Storper and Venables (2004), the authors refer in particular to the ease of communication and information exchange between different actors in the urban space as the source of a local buzz economy. A recent article by Rodriguez-Pose and Fitjar (2012) highlights the need for a broader interpretation of urban buzz: this concept is a container for local entrepreneurial dynamism (Acs et al. 2008), innovation access and intensity (Duranton and Puga 2001), knowledge generation and diffusion (Puga 2010), competitive cluster formation (Porter 1990), industrial districts (Pyke and Sengenberger 1992), learning areas (Morgan 1997) or spatial systems of innovation (Cooke et al. 1998). More detailed analyses of buzz phenomena can be found *inter alia* in Amin and Thrift (1994), Gertler (1995), Bathelt et al. (2004), McCann (2008) and Polèse (2009). Many of these contributions point out important elements of dynamic urban developments, but in most cases, a solid evidence-based econometric test of the underlying hypotheses is missing. The main ambition of the present study is to offer a statistical–econometric framework for examining the relevance and empirical validity of the urban buzz hypothesis.

According to some authors, buzz may be regarded as a decisive and prominent force of the city (Asheim et al. 2007; Kourtit and Nijkamp 2013d; Storper and Venables 2002, 2004). Urban buzz is based on intensive social interactions in a compact urban space, predominantly through physical face-to-face contacts. This geographically concentrated phenomenon serves to enhance social and economic interaction through communication, message transmissions, information acquisition, social contacts, knowledge and learning mechanisms, creativity exchanges and so forth. Buzz stems essentially from agglomerations advantages and is driven by socio-economic externalities in relation to social trust and social bonding. Spatial co-presence is an important action-oriented condition for information acquisition and selection in buzz areas. Modern information technology – in particular, the Internet – offers a critical vehicle for real-time urban buzz behaviour.

Clearly, an urban buzz district is a combination of buzz producers (e.g., restaurants, theatres, entertainment centres, recreation parks) and buzz consumers (e.g., visitors, recreationers, residents). Thus, urban buzz does not refer to people per se, but mainly to the positive externalities created by the interface of various actions and behaviours in a given urban district, resulting from density, proximity and

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connectivity. In essence, urban buzz originates from social and spatial networking of people with a high preferential attachment. Of course, in a cross-sectional data environment of spatial modelling without a panel structure, endogeneity issues may arise, but at least a potential explanation can be strived for.

Buzz in the city is thus essentially a specific form of spatial-functional cluster behaviour instigated by external advantages derived from spatial 'nearness' based on social communication and face-to-face interaction (Bathelt et al. 2004). According to the latter authors, buzz refers to social information and the communication ecology created by face-to face contacts, and co-presence and co-location of people and firms within the same industry and place or region. In many cases, urban buzz refers to specific life styles or professional communities, e.g. in the arts, cultural or creative sector (see e.g. Currid and Williams 2010).

It should be noted that urban buzz may relate to socio-economic factors and productivity-enhancing factors. The first class relates to the economies of cultural and social diversity in urban areas (Jacobs 1961 1969; Waldinger et al. 1990; Choenni 1997; Perdikogianni and Penn 2005; Sahin et al. 2007; Longhi et al. 2010; Kahanec and Zimmermann 2011; Kourtit and Nijkamp 2012). Such social buzz factors create various advantages for the population concerned, such as a great variety in product supply, variability in skills and socio-economic capabilities (e.g. ethnic entrepreneurship) (Masurel et al. 2002; Kloosterman and Rath 2003; Zhou 2004; Kourtit and Nijkamp 2011; Ozgen et al. 2011; Sahin et al. 2012), seedbed functions for new forms of art and culture, etc. The second class is more focused on business sector advantages, such as a rise in innovativeness, access to creative ideas, vicinity of institutions for higher education, use of advanced telecommunication systems and networks, etc.

Urban buzz is certainly not a phenomenon that is uniformly spread over all population groups in the city or urban districts. There is a clearly demographic component involved with intra-urban dynamics, in particular in regard to the ethnic variety in modern cities. The underlying idea is that in modern cities a great deal of socio-economic dynamics is created by various types of foreign migrants. In particular, the rise of migrant entrepreneurship has led to unprecedented dynamics in many cities such as the 'Soho economy' in London (see e.g., Sahin et al. 2011; Kourtit and Nijkamp 2012). Cultural diversity in relation to urban buzz is a fashionable topic in modern social research and is often seen as a positive attraction factor in urban districts. For a full description of this concept and its implications for urban welfare we refer to a recent study by Bakens et al. (2013), while an extensive overview of its measurement and the importance of the locality can be found in Nijkamp and Poot (2013).

In many cases, urban buzz appears not only all over a city, but in dedicated or specific areas where a concentration of initiatives, innovations and interactive expressions of lifestyles are taking place. This action place of urban buzz resembles the *piazza* of old Italian cities, where in the past all activities and

communications in the city were concentrated. The *piazza* is essentially the spatial bundling of urban buzz and very much depends on factors relating to both the built environment and the socio-economic conditions. Therefore, in our research on the spatial expression and geographic projection of urban buzz, we will concentrate our efforts on the economic functioning and outreach of such *piazza*s in modern cities.

We will focus our attention in this paper mainly on urban social networks, in particular from a cultural diversity perspective on urban buzz. Clearly, there are other determinants of local dynamism as well, but we will offer in this contribution an explanatory analysis of the broader cultural diversity components of an urban buzz constituency. Thus, we will regard creative classes, migrants and social media users as major change agents in a local or urban economy, at the interface of urban buzz and cultural diversity.

3.   Methodological Framework for Urban Buzz Analysis

From the previous section, we conclude that urban buzz results from a series of urban network and bonds factors. Some have a more physical background, like urban form or infrastructure, while others stem from the characteristics of the local environment associated with the people who live or spend time there, like the type of amenities available (e.g., entertainment). Additionally, as this study argues, the presence of a culturally diverse neighbourhood might be considered as an additional amenity that is highly valued by the main actors who drive urban buzz and hence induce a higher intensity of activity and interactivity. Now we will test the above propositions on the basis of a case study in the Netherlands.

Our empirical contribution is centred around the city of Amsterdam. Two main reasons explain the decision to opt for this location. In the first place, Amsterdam has a long tradition of openness and tolerance. Historically, the city has offered shelter to various cultures and ethnicities and has shaped its character around this idea of social inclusion. If cultural diversity is to have an effect on the popularity of a given area within a city, this effect is likely to show up in Amsterdam more than anywhere else. Secondly, on a more practical level, Amsterdam is sufficiently large, culturally-oriented and high-tech-savvy to induce a degree of penetration of location-sharing services for both residents and visitors that ensures meaningful results when using the data set designed to capture urban buzz. We use the boundaries of the municipality of Amsterdam to delineate the spatial extent of our analysis. Furthermore, in order to study the variation of activity within the city, we use the neighbourhood ('buurt' in the Dutch terminology) level, because it combines an appropriate spatial resolution and a set of relevant data on the migrants' presence.

In order to test formally the effect of cultural diversity on the level of buzz, we need to translate the

ideas from the previous section into a framework that allows for hypothesis testing. In particular, we use regression analysis to estimate the existence and importance of such an effect. Based on the literature reviewed in the previous section, we hypothesize that the volume of buzz in a particular area of a city may be conceptually expressed as a function of the following factors:

$$B_i = \alpha + \beta_1 F_i + \beta_2 E_i + \gamma Div_i + \varepsilon_i \tag{1}$$

where B_i is the level of buzz in neighbourhood i, α is an intercept term, F_i is a set of variables relating to the amount of possibilities for buzz to occur in i, E_i is a group of variables describing different characteristics of the urban form in i, Div_i is the level of cultural diversity that characterizes i, and ε_i is a well-behaved error term. At the same time, β_1, β_2 and γ are parameters that capture the effect on the level of buzz. The particular implementation, the definition and methodology to quantify buzz in B_i, as well as the actual selection of variables that we consider to represent F_i, E_i and Div_i empirically, are explained in detail in Section 4.

Ultimately, what we are interested in is the sign and magnitude of γ, which will allow us to examine whether cultural diversity does indeed have an effect on buzz at an intra-urban level. A positive sign will point to a positive impact, meaning that the more cultural diversity, the higher the buzz; the opposite will apply if the sign is negative. An insignificant coefficient would suggest no evident relationship between the two. However, this analysis can also shed some light on other determinant factors. Since the idea of quantitatively measuring buzz in a city is one of the novel contributions of our work, the question of which aspects of a neighbourhood matter for the level of local activity is also of interest in this context. This means that we will also pay attention to the sign and magnitude of the estimates of β_1 and β_2. They will help us to gain a better understanding of the nature of buzz and the type of human activities and economic functions that trigger this phenomenon.

The distribution of buzz across Amsterdam is likely to have a marked spatial dimension. Some parts of the city, such as the historical old town, will most likely have much higher levels of (inter)activity than other more peripheral and residential ones. At the same time, this pattern is not likely to match the administrative boundaries of the neighbourhoods perfectly. While these entities do capture to some extent the socio-economic characteristics that drive the outcome, they remain fairly stable over time and hence cannot accommodate the more dynamic nature of buzz. If this is the case, spatial autocorrelation will be present in the data that we observe, since the spatial unit we use (i.e. neighbourhood, see Section 4) does not perfectly capture the extent of the phenomenon we are studying, viz. urban buzz. The issue of spatial

autocorrelation, although in essence a rather technical econometric problem, may have important consequences for the final conclusions drawn from our analysis. In particular, failing to account for the spatial correlation of the dependent variable in an econometric model when necessary makes the estimates biased and inefficient (Anselin 1988). For that reason, we decided to expand the baseline model to include what is commonly known as a 'spatial lag': an explanatory variable that expresses the value of the dependent variable in the surrounding neighbourhood. In particular, the extended model may be formulated as:

$$B_i = \alpha + \rho \, \Sigma^N_j \, w_{ij} B_j + \beta_1 F_i + \beta_2 E_i + \gamma Div_i + \varepsilon_i \tag{2}$$

where ρ is a parameter and w_{ij} is the value of row i and column j of the spatial weights matrix W. This NxN matrix contains a formal representation of the spatial relationships between all the observations in the sample; if i is defined as a spatial neighbour of j, $w_{ij} > 0$; otherwise, the weight assigned to such a relationship is zero. When W is row-standardized, the spatial lag of B_i effectively becomes the average value of B in i's surrounding locations.

The justification for the introduction of a spatial lag in this context is akin to the filtering of temporal correlation in the time series literature.[1] If we consider equation (2) in matrix form:

$$B = \alpha + \rho W B + \beta_1 F + \beta_2 E + \gamma Div + \varepsilon \tag{3}$$

and rearrange it, we obtain:

$$B - \rho W B = B(I - \rho W) = \alpha + \beta_1 F + \beta_2 E + \gamma Div + \varepsilon \tag{4}$$

which reflects the correction of the spatial scale mismatch present in B by the operator $(I - \rho W)$. This introduction, however, has clear implications for the estimation method required. A spatial lag of the dependent variable introduces endogeneity into the model that must be accounted for and corrected when the model is estimated. To that end, we use OLS for the baseline equation but adopt a maximum likelihood (ML) approach, as suggested by Anselin (1988), for the spatial lag model.

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[1] For a similar discussion in the context of housing prices, we refer to Anselin and Lozano-Gracia (2008).

4.   Database

4.1 Measuring buzz with location-sharing services

The present study adopts a novel approach to measuring buzz within an urban environment. We take advantage of a new phenomenon that is spreading quickly among the creative residents of cities: location-sharing services. These are online applications with which users, empowered by a location-aware device connected to the Internet, such as a smartphone or tablet, can share their geographical position at a given point in time with their friends and broadcast it on the Internet. To offer a sense of their degree of penetration, Foursquare, one of the main leaders in this industry, claimed to be processing at least one million posts per day in 2010 (Grove 2010). Since then, its popularity has increased even more, particularly among the young and skilled stratum of the population. A key piece of these services is what has come to be known as 'check-in'. Whenever a user finds him/herself in a place and wants to share it with his/her social network (and potentially with the whole Internet), this kind of mobile application can be used to 'check in'. The place where the check-in occurs, or venue, can vary greatly in its nature: from a bar or restaurant to a train station or even a park; most urban spaces can be 'checked into'. A check-in is not only defined by the place/venue where the user finds him/herself at a particular moment, but also by its accurate coordinates (provided by the digital device carried) and a time stamp. This degree of detail automatically translates into a data set with very high granularity in both space and time.

The data set we employ for this application comprises more than 70,000 check-ins extracted by the original database presented by Cheng et al. (2011). Throughout most of 2010 and the beginning of 2011, Cheng et al. (2011) crawled the social network Twitter to compile check-ins from Foursquare broadcast, not only to the immediate social network but to the whole Internet. This yielded more than 20 million observations that they later released[2] in an open format and that have already been included in some studies by other researchers (see e.g. Cranshaw et al. 2012). Although the observations are scattered all around the world, because they are georeferenced, we can subset them to consider only those that occurred within the Amsterdam city boundary limits. In its basic form, each observation includes the latitude and longitude of the check-in, a time stamp and some text from the tweet, which we use to link it to the venue and then are able to obtain more characteristics (see Section 4.2 for a more detailed explanation). These data, although appealing, are not without drawbacks. One in particular stands out: it is not possible to know details about the characteristics of the users, since they are for privacy reasons

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[2] See http://infolab.tamu.edu/data for more information.

anonymized. This means that we cannot trace back the origins of buzz (who is *producing* it) and thus we cannot be totally sure about who is the sender. This certainly limits some of the applications the data set could be used for, since it prevents us from delving more deeply into the actual nature of the buzz, but not all of them. In particular, the focus of our paper, the extent to which cultural diversity and other socio-economic factors influence the volume of buzz in a neighbourhood (whoever this activity comes from), can still be tested.

Table 1 shows some descriptive statistics while Figure 1 displays the distribution of the check-ins, both at the point level (points have been made extremely small and transparent in order not to overcrowd the figure) and aggregated at the neighbourhood level, which is the unit we will be using for the analysis. The check-ins closely match the spatial structure of Amsterdam. Smaller, more central and denser neighbourhoods of the historical centre capture most of the check-ins, while peripheral, larger areas devoted to residential and industrial uses (e.g. the harbour in the North-Western part of Amsterdam) barely attract any activity. An exception is a large polygon in the South Eastern part of the city, which shows a large volume of check-ins, considering its location and neighbours. This corresponds to the Bijlmer area, where a whole entertainment centre has been developed, including the soccer team (Ajax) Arena stadium, many cinemas and a large concert hall. By looking at the map, one can easily conclude that the data set is appropriate for measuring urban buzz at a very detailed level.
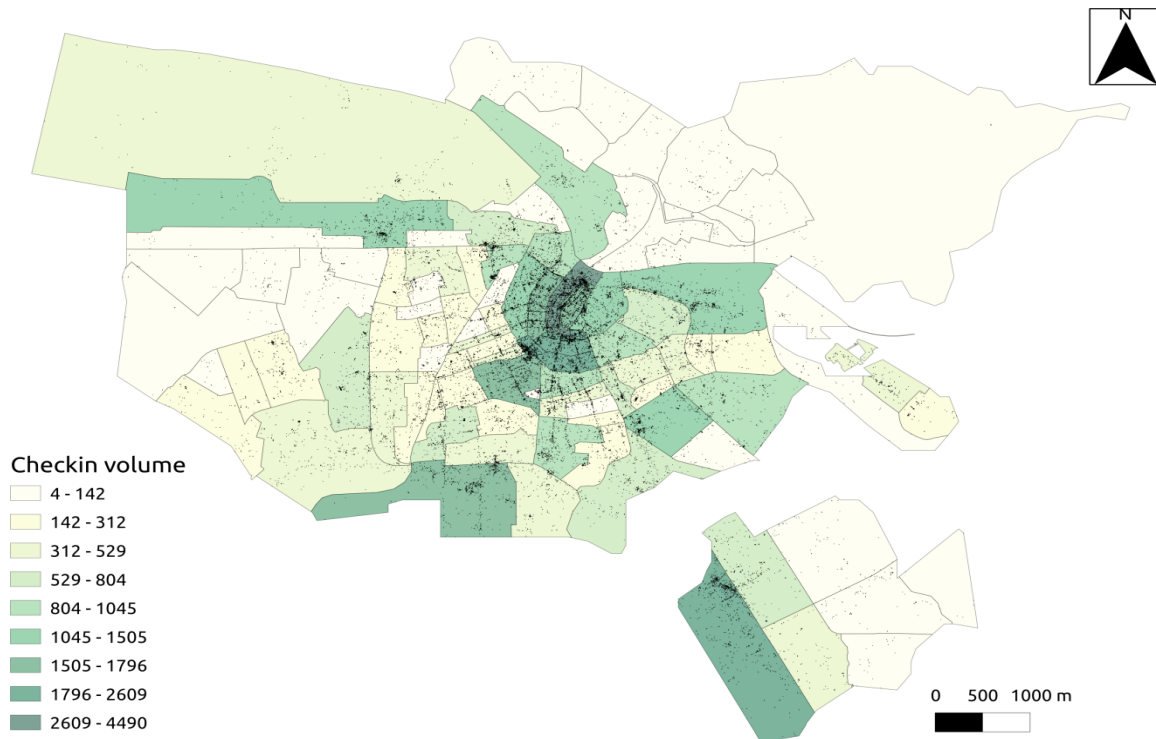
Figure 1. Distribution of the volume of Foursquare check-ins

4.2 Cultural diversity and land use data

Once we have presented our measure of buzz, the effect of cultural diversity can only be examined by adopting an index that captures its presence in a quantitative way. Although the literature on how to measure this phenomenon is extensive and rich (e.g. Sassen 1994; Alesina et al. 1999; Alesina et al. 2004; Boeri and Brücker 2005; Musterd and Deurloo 2006; Ottaviano and Peri 2006a,b; Nijkamp 2008; World Bank 2006; Evans 2009; Kourtit and Nijkamp 2011; Ozgen et al. 2011b), in this case we decided to take a traditional approach and adopt a well-established index. In particular, we use the index of fractionalization, presented by Mauro (1995) and widely employed in other studies on the effects of cultural diversity, such as that of Ottaviano and Peri (2006). Its formal expression is:

$$Div_{i\,r} = 1 - \Sigma^{M}_{i=1}\ (CoB^{r})^{2} \qquad \qquad _{i} \qquad \qquad (5)$$

where Div_r is the diversity index in area r, M is the total number of different cultural origins and $CoBr$ is the share of the population with cultural origin i in area r. The index is bounded between 0 and $(1 - 1/M)$ and accounts for two aspects of cultural diversity: the richness, or how many different groups there are, and the evenness, or how the population is distributed across those groups. In an extreme case in which everyone in a neighbourhood belongs to the same group, the probability of picking up two different groups at random is non-existent and, accordingly, $Div = 0$. As a neighbourhood includes more variety (M increases) and the distribution across them remains even or proportionate, the probability of randomly selecting two different persons increases, and so does the index. To calculate this measure in the Amsterdam neighbourhoods, we use data from the Dutch Bureau of Statistics (CBS in its Dutch acronym). At that level of resolution, we can access the shares of immigrants in the following groups: Western migrants, Moroccans, Surinamese, Turkish, and migrants from the Dutch Antilles and other origins. In this context, a person is considered to be a migrant, if at least one of his/her parents was born outside the Netherlands. Equally, a migrant is considered to be a Westerner, if he/she comes from Europe, North America, Japan, Indonesia and Oceania. This implies that, in the context of equation (5), $M = 7$, and thus the maximum degree of diversity we can reach in our data set is 0.86. Information about the distribution of the diversity index in the sample used for the analysis may be found in Table 1.

Table 1. Descriptive statistics

	mean	std	min	25%	50%	75%	max
Foursquare – Arts and Entertainment	7.993	12.322	0	0	0	15.885	46.154
Foursquare - College and University	1.503	7.377	0	0	0	0	50
Foursquare – Food	6.498	16.068	0	0	0	5.794	100
Foursquare – Other	46.072	30.457	0	25	50	63.727	100
Foursquare - Outdoors and Recreation	1.617	10.620	0	0	0	0	100
Foursquare - Professional and Other Places	12.212	22.494	0	0	0	16.667	100
Foursquare - Travel and Transport	7.041	16.066	0	0	0	11.111	100
Industrial use	7.195	14.445	0	0.789	1.970	4.892	76.820
Office use	8.522	12.679	0.014	1.399	3.652	10.339	84.004
Sports use	1.351	3.579	0.000	0.090	0.363	1.204	29.413
Retail use	3.409	3.666	0	1.308	2.382	4.416	29.075
Total venues	12.865	22.032	0	1	6	11	116
Total units	4.822	3.001	0.013	2.390	4.844	6.723	14.763
Diversity	6.014	1.447	0	5.249	5.992	7.252	8.066
Volume of checkins	806.531	1070.210	5	147.000	422.000	1028.250	6620

In addition to cultural diversity, we include other variables to explain the volume of check-ins in a neighbourhood. These are introduced to control for the number of possibilities available to users and for the economic function of the area. The first set of controls is extracted from the Foursquare, Inc. (2012) database using their Venue platform. It contains information about all the venues where the users checked in during the time the check-ins data set was compiled.[3] In order to use it in conjunction with the cultural diversity index in a regression framework, we aggregate the data to the relevant neighbourhood level and simplify it to include only major venue categories. The result is reflected in the eight following variables: the total number of venues as well as the percentage of venues in 'arts and entertainment', 'college and university', 'food', 'outdoors and recreation', 'professional and other places', 'travel and transport' and 'other'. Some other minor categories were initially considered, but dropped later due to multicollinearity. Basic statistical information of the variables included in the rest of the analysis may be found in Table 1.

The last source we use in this study introduces land use data. These come from the Dutch register of addresses and buildings (BAG, to use its Dutch initials[4]), which keeps track of the land use category at the unit level, even within a building. In the municipality of Amsterdam, this means almost half a million records. Similarly to the venue data, we need to bring these to a spatial unit at which they can be linked to the degree of cultural diversity in the locality concerned. This is possible by aggregating areal size devoted to each use in every neighbourhood and by calculating next the percentage it represents of the total. For this analysis, we use the percentages of use in the following categories: industrial, office space, sports and retail. Additionally, we include the number of units, which is correlated with the building density and the urban form of the area. Aggregate information at the neighbourhood level is displayed in Table 1.

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[3] The process of linking check-ins with the venue where they occurred consisted of extracting the link of the venue from the tweet text to query later the Foursquare venue platform for further information.
[4] For more information, see http://bag.vrom.nl/.

5.   Empirical Results

In this section, we present the results and main interpretation of applying the methodology outlined in Section 3 to the data described in Section 4. In the first place, as a benchmark, we adopt a non-spatial approach and estimate equation (1) through traditional OLS, which allows us to obtain a set of baseline results. In the second stage, we introduce a spatial lag into the model and estimate the results via maximum likelihood (ML henceforth), as expressed in equation (2). Finally, we present an extension in which we 'stretch' the data into a pseudo-panel, taking advantage of the temporal granularity of the Foursquare data, in order to break the results into different times of the day.

The first column of results in Table 2 shows the coefficients estimated for the non-spatial model using traditional OLS. Focusing first on the control variables, we can see that they show the expected signs. A higher density of buildings, measured by the total number of units (within buildings) in the neighbourhood, has a large positive impact; that is, the more crowded and denser the area, the more Foursquare activity it receives. This is a plausible and anticipated result that nevertheless can be taken as a sanity check on the validity of the data set. In this respect, it is important to mention that this variable offers a control for population (number of units and population are highly correlated) and, in conjunction with land-use shares, a disaggregate view of the effects of density, both having been mentioned in the introduction as drivers of urban buzz[5]. Intuitively, the presence of more possibilities to 'check in' measured by the amount of venues, leads to higher total volumes of activity. In terms of shares, larger proportions of all the categories included, with the exception of 'college and university', are associated with more activity as well. The strongest effect, unsurprisingly, comes from the presence of venues in the category 'arts and entertainment', in which most cultural amenities, such as museums and cinemas, are included as well as some bars.[6] This is in line with the consumption amenity nature of Foursquare check-in data and reinforces the argument that they constitute a good index of urban buzz. Different proportions of land use in a neighbourhood shape different profiles in terms of its socio-economic role within the larger context of the city. This is reflected in the coefficients for the shares of land use types. The presence of office and of retail space, both functions that attract day-time activity, significantly increases the number of check-ins an area receives. Somehow counterintuitively, a significant and positive coefficient is associated with industrial use. This might be driven by areas that used to be industrial (and

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[5] We ran additional regressions including area and population figures and the results were robust: although the point estimates change slightly, neither the significance nor the main conclusions drawn from the analysis change. Tables are available by the authors upon request.

[6] The coding scheme that determines which category a venue falls into is not totally deterministic in that it depends on the judgement of users. Because of this, for example, some bars are coded as 'arts and entertainment', while others are part of 'food'.

are still coded that way), but in recent years have undergone regeneration processes that have attracted many cultural activities (e.g. the northern docks across from the Central Station of Amsterdam), as strong drivers of 'check-ins'. The model seems to offer a plausible explanation for the data and capture correctly most of the anticipated effects on the levels of Foursquare activity. In addition, it captures a good deal of the variation in the data, reaching an R^2 of slightly over 0.73, which gives us confidence in the specification and in the subsequent interpretation of the effect of diversity.

The estimated effect of diversity is 0.0152 (0.1518 × 10, due to rescaling) and the coefficient is significant at the 10 per cent level. This implies that, according to our model, a unity increase in the degree of cultural diversity present in the neighbourhood induces a boost in the number of 'check-ins' of approximately 1.5 per cent. If that is the case, the evidence from this study suggests that Foursquare users positively value cultural diversity and, everything else being equal, show a preference for relatively diverse enclaves when they check in (the 'Soho' effect). If we assume that this is a good proxy to measure where activity (i.e. urban buzz) is located within the city at a given point in time, we are thus arguing that cultural diversity in fact does have a positive and significant impact on urban buzz, at least for the case of Amsterdam.

The results shown so far relate to a model that does not explicitly take into account the spatial detail. In that context, the observations are assumed to be independent of each other, regardless of where they are located in space. However, as we have noted in Section 3, if that is not the case and the spatial scale we are using does not completely encapsulate the values of urban buzz, we might be incurring a bias when estimating the coefficients (Anselin 1988). In order to account for these spatial effects properly, we estimate[7] the spatial lag model in equation (2) via ML. There are two details that we have to take care of before delving into the results. The first one is the nature of the spatial relationships we introduce in the model through the weights matrix W. The choice of one or another type has to be made ex ante and, consequently, the use of W has often been criticized in the literature (see e.g. Gibbons and Overman 2012). In this study, we adopt a pragmatic approach and test several different specifications to ensure that our results and conclusions are not exclusively tied to the choice of a particular W. In particular, we have tried K-nearest neighbours ($k = 6$), a distance threshold and contiguity weights based on the queen criterion (i and j are neighbours, if they share at least an edge or vertex). Because the estimates are very similar and the conclusions do not change, we only report the results for the latter. In addition, we always row-standardize the matrix, so that the spatial lag can be interpreted as the average value of an observation in its vicinity. The second issue relates to the assumption of normality implicit in an ML

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[7] All the computations relating to spatial methods in this paper were performed using the Python library PySAL (Rey and Anselin 2010).

estimation, as reliable estimates are only to be obtained if this condition holds. The bottom of Table 2 shows the Jarque–Bera test of normality, which takes the null of a normal distribution in the OLS residuals and, if rejected, can be taken as a sign of an estimation problem. We obtain the value 1.711, which we cannot reject, leading us to conclude that ML is an appropriate estimation method for our model. Finally, in order to strenghten our choice of a spatial lag specification, the very bottom of the table shows the results of the ML diagnostics of spatial dependence, which offer guidance on the spatial data generating process (either a lag or an error, see Anselin 1988 for more details). When using the more reliable robust version, the indication is clear towards a spatial lag process.

Table 2. Results for the aggregated volume of *check-ins*

	OLS	ML-Lag
Foursquare – Arts and entertainment	0.0285***	0.0158**
	(0.008)	(0.007)
Foursquare – College and university	-0.0104	-0.0063
	(0.012)	(0.010)
Foursquare – Food	0.0208***	0.0132***
	(0.006)	(0.005)
Foursquare – Other	0.0121***	0.0128***
	(0.003)	(0.003)
Foursquare – Outdoors and recreation	0.0171**	0.0093
	(0.008)	(0.007)
Foursquare – Professional and other places	0.0129**	0.0099**
	(0.005)	(0.004)
Foursquare – Travel and transport	0.0138**	0.0134***
	(0.006)	(0.005)
Industrial use	0.0184**	0.0217***
	(0.008)	(0.006)
Office use	0.0339***	0.0224***
	(0.008)	(0.006)
Sports use	-0.0271	-0.0213
	(0.030)	(0.024)
Retail use	0.0187	0.0408
	(0.032)	(0.026)
Total venues	0.0209***	0.0138***
	(0.006)	(0.005)
Total units	0.1853***	0.1737***
	(0.036)	(0.030)
Diversity	0.1518*	0.1267*
	(0.080)	(0.065)
Constant	2.1549***	-0.0511
	(0.524)	(0.670)
P		0.4399***
R^2	0.735	
Jarque–Bera	1.711	

LM Lag Robust LM Lag LM Error Robust LM Error	20.8748*** 12.0798*** 8.9422*** 0.1472	

*** Significant at 1%, ** significant at 5%, * significant at 10%, insignificant otherwise. Standard errors are shown in paretheses below the estimates.
'Total units' and 'diversity' are rescaled to avoid multicollinearity issues by pre-multiplying them by 0.001 and 10, respectively.

The spatial lag results are reported in the second column of Table 2. The general conclusions of the model point in the same direction as in the OLS case, since no sign or level of significance is greatly affected. However, it can be seen that the coefficients are in the vast majority (with the exception of one significant variable) overestimated: when space is accounted for in the model, their magnitude is more limited. This is also the case with the coefficient of diversity, which is downwardly corrected from 0.15 to 0.13, but remains significant at the 10 per cent level, pointing to a significant impact of a more diverse neighbourhood on its level of buzz. The OLS upward bias is a typical result when positive spatial autocorrelation is present and highlights the importance of these methods in dealing properly with spatial effects and obtaining correct estimates. The ρ parameter, associated with the spatial lag of the dependent variable, is slightly larger than 0.4 and highly significant. This is an indication of a process of positive spatial autocorrelation whereby neighbouring observations tend to have similar values.

The last piece of the analysis comprises an exploration of the granular temporal dimension of the Foursquare data. We set out to study how the impact of cultural diversity varies across the time of the week. For every neighbourhood, we disaggregate the number of check-ins by the time of the week and rerun different models of equation (2), using the volume of activity in each time slot as the dependent variable. The following times of day are considered: morning (5 a.m. to noon), weekday afternoon (noon to 6 p.m.), evening (6 p.m. to 10 p.m.) and night (10 p.m. to 5 a.m.). Each of these is further divided between weekday (Monday to Friday) and weekend (Saturday and Sunday), resulting in eight different times of the week. Figure 2 displays the ML estimates[8] for the coefficient of diversity for each time of the week, along with the 95 per cent confidence intervals. The effect is lowest on a weekday morning and grows over the day to reach its peak during the night of a weekday. Over the weekend, the effect

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[8] Although we only present ML estimates from the spatial model, we tested several alternative specifications, including a pooled regression, a regime regression using the time of the week as the regime variable and spatial versions of these. Since all the main conclusions remain unchanged, we only show the ML models for consistency with the previous part of the analysis. Additional results are available from the authors on request. Equally, although we only show the estimates for diversity, full model results are available.

decreases a little in the morning but picks up again during the evening and night. Except for the weekday mornings, they are all significant at the 5 per cent level. This pattern is not only plausible, but also very much consistent with the idea of cultural diversity valued by Foursquare users as a consumption amenity: in typical working hours, its effect is negligible, but as the use of time shifts more into leisure and entertainment, the effect becomes more relevant, highlighting that users particularly prefer diverse neighbourhoods for the activities they engage in at the end of the day or during the weekend.
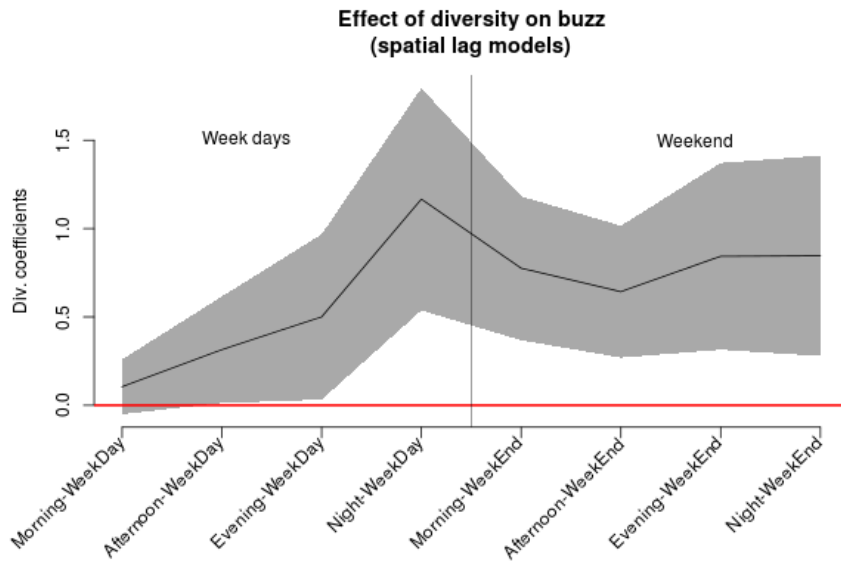
Figure 2. Coefficient estimates and 95 per cent confidence intervals

6.   Conclusion and Policy Perspectives on Urban Buzz

This paper adopts a novel data set and original approach to measuring urban buzz quantitatively and to studying its main determinants, with a particular focus on the effect of cultural diversity in urban districts. Using data from the online location-sharing service Foursquare, we quantitatively define urban buzz as the 'check-in' volume per neighbourhood and present an empirical model for the city of Amsterdam. This includes not only a measure of cultural diversity, but also information on the availability of venues to 'check into' as well as on land use, and properly accounts for the presence of spatial autocorrelation in the buzz variable. The main results suggest a positive and significant effect of cultural diversity on the level of buzz activity that occurs in a neighbourhood. This implies that, given the same economic functions and availability to check in, a greater level of cultural diversity is associated

with a larger volume of check-ins.

The use of digital technology data is instrumental in smart city management (see also Federowicz and Dias 2010; Frey et al. 2010). This does not only hold for Foursquare data, but in general for all digital information. The management and policy uses of such massive data call for intelligent data analysis; a compact representation of 'big data' in cities may be helpful for:

- pattern recognition of stocks and flows (e.g., people, real estate, infrastructure);
- provision of public services in urban hotspots (e.g., ambulances, police);
- monitoring of urban developments (e.g., office developments, commuting patterns, shopping behaviour, public transport use);
- identification of problem situations or bottlenecks (e.g., transport management, crowd management);
- projection of future developments (e.g., accessibility, congestion).

A systematic effort to translate a 'data-rich' urban environment into a strategic control-oriented urban information system is one of the great challenges of our urban era. Urban buzz areas may become prominent anchor points for smart cities.

Urban buzz reflects the utility-enhancing potential of urban areas as a result of density, connectivity and proximity advantages among the heterogeneous groups – including distinct migrant groups – that reside in or visit modern cities. Creativity and diversity appear to be key factors in the dynamic performance conditions of such areas. What can policy do to favour such urban buzz phenomena? Urban buzz finds its genesis in urban agglomeration advantages of various kinds, and it seems plausible that policy efforts to exploit the benefits of urban territorial capital (including social, creative, entrepreneurial and innovative capital) may concentrate on the provision of conditions that favour such capital. Land use policy, educational policy and entrepreneurial stimuli may then offer promising strategic directions. Moreover, since the results presented in the previous sections point to a positive and significant effect of cultural diversity on this phenomenon, a focus from policy makers on protecting and even stimulating such attractiveness characteristics of cities and neighbourhoods is an additional recommendation that derives from this study.

Especially in a European setting – where most cities house a wealth of cultural heritage that often acts as an attraction force for innovative activities – due policy attention to the exploitation of historic–cultural resources as a source of economic progress would be meaningful. There is an increasing awareness in Europe that cultural heritage is not meant to craft a city in stone, but that the past can be used as an engine for economic progress, by attracting visitors, business and residents.

This study represents a first experiment to explore the usefulness of new data sources originating

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from the Web and how they can be employed to answer questions about the physical world. In this sense, the positive results obtained regarding the main question asked at the beginning of the paper (how does cultural diversity affect urban buzz?) should prompt more research activity in the future rather than being taken as a road end. In particular, and without being exhaustive, we will conclude by suggesting three avenues that we consider especially relevant. Further research could extend the present results by looking at the components of diversity in relation to urban buzz (which particular socio-economic groups have greater participation?) and trying to disentangle the potential identification issues by including information on wages and the wage gaps between groups. An aspect that has been assumed throughout the paper but that would certainly be interesting to test empirically too is the extent to which the effect of urban buzz influences − or is related to − the socio-economic development of a neighbourhood. Finally, a deeper analysis of the nature of Foursquare data, aiming to delve into the intricacies and characteristics of its users as well as their socio-demographics, would also be illuminating. For all those reasons, this study should be taken as an inspiring starting point rather than as a conclusive end point.

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