The Value of Culture to Urban Housing Markets[§]

Riccardo Borgoni[*] Alessandra Michelangeli[$] Nicola Pontarollo°

Abstract

Cultural amenities are the expression of a cultural environment, given by a combination of aesthetics factors, styles, rhythms, and behaviours, which contribute to make a neighbourhood vibrant and more enjoyable. Following the hedonic approach, we propose an empirical strategy to capture the multiple effects of cultural amenities, as well as the effects produced by green areas, public transport and university proximity. The results are used to determine whether cultural amenities are optimally provided by the municipality of Milan. It emerged that: *(i)* investments in culture generate positive effects to society; *(ii)* the governments should devote far more resources to culture.

Key Words: culture; city; hedonic approach; multilevel models.

JEL Codes: R11; R12 ; R23.

[*] DEMS -University of Milan-Bicocca, Piazza dell'Ateneo Nuovo 1, 20126 Milan (Italy). E-mail address: riccardo.borgoni@unimib.it

[$]DEMS - University of Milan-Bicocca, Piazza dell'Ateneo Nuovo 1, 20126 Milan (Italy). E-mail address: alessandra.michelangeli@unimib.it

° Joint Research Centre European Commission, Via Enrico Fermi 2749, I, 21027 Ispra (Italy). E-mail address: nicola.pontarollo@ec.europa.eu

1. Introduction

Culture is a key driver for economic and social development of a community. As regard to economic contributions, cultural activities and related infrastructure are thought to attract recreational facilities, such as shops and restaurants, and generate incomes that are subsequently spent locally by residents, visitors and staff (Falck et al., 2015; Koster and Rouwendal, 2016). Moreover, art and cultural institutions contribute to revitalize urban areas, as shown, for instance, by Strom (2002) for different cities in the US and by Russo and Van der Borg (2010) for Europe. Several international organizations, such as the Organization for Economic Cooperation and the European Commission, outline the importance of cultural equipment and infrastructure in enhancing local development, livability and attractiveness of urban areas (Boualam, 2014). As regard to social contribution, the European Commission (2014) argues that art and culture play an important role to strength the social cohesion of different layers of the population, in addition to fostering personal development and the respect for diversity. The former European Commission President José Manuel Barroso said: "*Culture and creativity touch the daily life of citizens. They are important drivers for personal development, social cohesion and economic growth. But they mean much more : they are the core elements of a European project based on common values and a common heritage – which, at the same time, recognizes and respects diversity. Today's strategy promoting intercultural understanding confirms culture's place at the heart of our policies*" (European Commission, 2007 p.1). In his popular contributions, Florida (2002a, 2002b; 2005) shows that the concentration of people strongly involved in creative and cultural activities is significantly correlated with higher wages, housing values, innovation, human capital and tolerance.

Although it is recognized the importance of culture, in some countries like Italy there has been a strong disinvestment in culture. According to the Italian Department for Development and Social Cohesion (2013), the primary expenditure for culture represented the 1.7 per cent of GDP in 2000 and decreased to 1.3 per cent in 2011. Investments in culture decreased at an average annual negative growth rate of -33.3 per cent, when the per capita GDP had a reduction of -1.9 per cent over the same period.

This paper focuses on the measurement of the social benefits produced by culture, by considering cultural equipment and infrastructure as cultural amenities. The latter are supposed to have a positive impact on household's utility and subsequently to play an important role in household's location choice. Quantifying the importance of cultural amenities and discuss the potential role of the public policy in their provision is the main aim of the paper. To this purpose, we consider a hedonic pricing model applied to the housing market of a city to estimate the implicit price associated with culture. Our contribution is twofold: first, we propose a new measure for cultural amenities, named Cultural Catalyzer, which is able to capture the "compositional effect power" of a bundle of cultural amenities; second, we develop an original empirical strategy for geo-referenced data. The paper shows how geocoded information can provide enormous advantages for socio-economic modeling. Geocoding allows to combine information from a range of different sources, such as *ad hoc* surveys, administrative or census records, or cartographic information, often freely downloadable from the web. The resulting dataset contains an amount of extremely detailed information on cultural amenities, green areas, public transport and education, which is not usually available in urban studies. In addition, this allows to investigate the phenomenon of interest at a very local detail where the socio-economic dynamics are of great interest but difficult to grasp. Geo-referenced data are used to construct variables for measuring the effects of amenities in an original way, i.e. combining both accessibility to amenities and their size or quantity. Accessibility accounts not only for the closest amenity, but also for the farther ones, weighting them according their distance from housing units.

Our empirical findings allow to determine whether cultural amenities are optimally provided by comparing costs and benefits associated with them in the city of Milan that, according to a report released by the European Commission (Montalto et al., 2017)[1] is the first Italian city for cultural and creative resources, in particular museums, theatres, libraries and creative spaces (incubators, co-working areas, exhibition spaces). This positive evaluation in terms of ranking is somehow coherent with the amount of investment in culture, which is the highest among the Italian cities after Florence and Trieste.[2] In the full ranking of the commission report, Florence ranks 28th, Trieste 52nd, while Milan ranks 15th. Nevertheless, our findings show that government should devote far more resources to culture in Milan and this suggests that investments should be increased even more in the other Italian cities.

The remainder of the paper is structured as follows. Section 2 reviews the literature on valuing cultural amenities. Section 3 introduces the theoretical framework. Section 4 describes the data. Section 5 discusses the empirical strategy. Section 6 presents the results and provides a cost-benefit analysis to assess whether the provision of cultural amenities are sufficiently founded. The last section concludes.

2. Related literature

In the economic literature, urban amenities are defined as local-specific characteristics with a positive impact on the household's utility. Those with a negative contribution on the household's utility are called disamenities (Blomquist, 2006). (Dis)Amenities play an important role in household location decision. Glaeser et al. (2001), for example, find that weather is the most important factor for population and house price rises at the county level in the United States.

(Dis)Amenities may be classified using different dimensions such as geographic scale, degree of permanence and the extent to which they are physically tangible (Bartik and Smith, 1987). Clark (2003) distinguishes between natural amenities and constructed amenities. In the terminology of Gyourko et al. (1991), natural amenities are non-produced public goods, which are jointly shared,

[1] The first edition of the report "Cultural and Creative Cities Monitor" shows how well 168 selected cities in 30 European countries perform on a range of three measures describing cultural and creativity resources of a city. The scores of these three measures are then aggregated in an overall index.

[2] Source: openbilanci.it; accessed 15-01-2017.

potentially consumed by all, and exclusion from them is costly. The most encountered constructed amenities in applied research are local fiscal conditions (taxes and public services), and cultural and recreational opportunities (Andreoli and Michelangeli, 2015). In this paper, statistical information about amenities in Milan allows us to consider both natural and different types of constructed amenities, namely parks, public transport, educational services and cultural amenities.

The literature about the evaluation of cultural amenities using the hedonic approach has been limited until recently. One of the first contributions is due to Clark and Kahn (1988). They consider a two-stage hedonic wage model to estimate the social benefits of cultural amenities in a large number of US cities in the '80s. In the early 2000's, Glaeser et al. (2001) and later Glaeser (2009) show that the presence of a variety of services and consumer goods, such as theaters, art museums and opera houses amongst others, leads to higher rents and population growth. More recently, there has been a growing interest in this topic, as evidenced by the increasing number of studies with empirical applications carried out on US cities, as well as on European cities. Moro et al. (2013) estimate several specifications of a hedonic price equation to establish whether the distance to, and the density of, cultural heritage sites are capitalized into housing prices in Greater Dublin, Ireland. Sheppard (2013) examines both theoretically and empirically the impact of the opening or expansion of museums on their neighborhoods using the hedonic approach applied to the residential housing market. Lazrak et al. (2014) provide one of the first applications of spatial hedonic analysis to investigate the impact of historic buildings and cultural sites on the value of real estate in Dutch urban areas. Falck et al. (2015) provide evidence of an increasing importance of cultural amenities in affecting district's quality of life in West German over 36 years, from 1976 to 2010.[3]

Similarly to what we have done in this paper, Koster and Rouwendal (2016) carry out a cost-benefit analysis, although they focus on historic amenities. Moreover, these authors distinguish between a direct and indirect external effect of investments in those amenities. The former is a positive effect

[3] From the terminological point of view, Glaeser et al. (2001) include culture among the consumption amenities, while Falck et al. (2015) refer to culture as a consumptive amenity.

on the market values of houses surrounding historic sites. The latter is due to the private investments of households improving the quality of their houses. This is expected to produce a positive externality for neighboring enjoying the improved housing quality and will cause a subsequent rise in housing prices. To estimate the total external benefits of investments in cultural heritage, the authors conduct a counterfactual analysis. As we will see in Section 6, their empirical findings in terms of benefits-to-costs ratio are not far from ours.

Even if this paper focuses on the value of culture for a community of households, it is worth mentioning that a strand of literature considers the impact of amenities not only on household's utility but also on firm's productivity. If amenities have a positive (resp. negative) impact on productivity and quality of business environment, then they are considered as production amenities (resp. disamenities). For example, Boualam (2014), in investigating how variations in the relative size of the cultural sector across U.S. metropolitan areas capitalize into rent and wage premia, finds that culture mostly affects firms than households.

3. Theoretical Framework

We consider a city partitioned into N neighborhoods, indexed by n, with a population of I perfectly mobile, price-taking households, indexed by i. Households dispose of income $\boldsymbol{m} = (m_1, \dots, m_I)$ and have preferences over two consumption goods: a numéraire composite good, denoted by x, and a unit of housing. Each unit of housing is characterized by a K-dimensional vector of objectively measurable housing-specific characteristics and amenities, $\boldsymbol{z} = (z_1, \dots, z_K) \in \mathbb{R}_+^K$, including culture. We denote by $\boldsymbol{D}$ the closed and convex set of all conceivable packages of the K housing-specific characteristics and amenities.

Households' preferences over the composite good and housing are represented by an increasing and strictly concave utility function $U_i(\boldsymbol{z}, x)$, characterized by a decreasing marginal rate of substitution between goods along an indifference surface. Let $P(\boldsymbol{z})$ be the observed equilibrium price schedule associated with the housing unit with characteristics $\boldsymbol{z}$. The optimal bundle $(\boldsymbol{z}_i^*, x_i^*)$ maximizes the utility of household i subject to the budget constraint and corresponds to the solution of the following problem:

$$\max_{(\boldsymbol{z},x)\in R_+^K} U_i(\boldsymbol{z}, x) \quad \text{s.t. } m_i \geq P(\boldsymbol{z}) + x. \tag{1}$$

First order conditions for the internal solution $(\boldsymbol{z}_i^*, x_i^*)$ imply the following set of equations:

$$\frac{\partial P(\boldsymbol{z}_i^*)}{\partial z_{ij}} = \frac{U_i(\boldsymbol{z}_i^*, x_i^*)_{z_{ij}}}{U_i(\boldsymbol{z}_i^*, x_i^*)_x}, \quad \forall j = 1, \dots, K \tag{2}$$

$$P(\boldsymbol{z}_i^*) = m_i - \boldsymbol{z}_i^*,$$

where $U_i(\cdot)_{z_{ij}}$ is the marginal utility of household *i* associated with amenity z_j, and $U_i(\cdot)_x$ is the marginal utility of household *i* associated with the numéraire. At the optimum, the marginal rate of substitution between z_j and the numéraire is equal to the marginal willingness to pay of household i for an additional amount of z_j.

We denote the household i's indirect utility function by $V_i(\widehat{m}_i)$, where $\widehat{m}_i$ is defined below. Household utilities are aggregated into a social welfare function expressed in formal terms as $W = W\big(V_1(\widehat{m}_1), \dots, V_I(\widehat{m}_I)\big)$. Social welfare function is continuously differentiable and increasingly monotonic. The distribution of observed incomes across households, denoted by $(\widehat{m}_1, \dots, \widehat{m}_I)$, is assumed to be optimal with respect to the social welfare function, i.e. $(\widehat{m}_1, \dots, \widehat{m}_I)$ are the solution of the following program:

$$\max_{(m_1,\dots,m_I)} W\big(V_1(m_1), \dots, V_I(m_I)\big) \text{ s.t. } \textstyle\sum_{i=1}^I m_i \leq \sum_{i=1}^I \widehat{m}_i. \tag{3}$$

As observed in Gravel et al. (2006), the hypothesis of optimal distribution of observed incomes implies to assert that the actual income distribution is considered “just” or socially optimal.

The social value of a marginal increase in amenity j quantity is given by:

$$\frac{\partial W}{\partial z_j} = \sum_{i=1}^{I} \frac{\partial W\big(V_1(\widehat{m}_1),\dots V_I(\widehat{m}_I)\big)}{\partial V_i} \cdot \frac{\partial V_i(\widehat{m}_i)}{\partial m_i} \cdot \frac{\partial P(\mathbf{z}_i^*)}{\partial z_{ij}} \cdot dz_j \qquad (4)$$

The optimality of income distribution implies that $\frac{\partial W\big(V_1(\widehat{m}_1),\dots V_I(\widehat{m}_I)\big)}{\partial V_i}$ is equal to the Lagrange-Kuhn-Tucker multiplier associated with the constraint $\sum_{i=1}^{I} m_i \leq \sum_{i=1}^{I} \widehat{m}_i$. in the maximization problem (3). Thus, equation (4) approximately reduces to:

$$\frac{\partial W}{\partial z_j} = \sum_{i=1}^{I} \frac{\partial P(\mathbf{z}_i^*)}{\partial z_{ij}} \cdot dz_j, \quad \forall j = 1, \dots, K. \qquad (5)$$

Equation (5) measures the social marginal benefits, obtained summing up the household marginal willingness to pay (MWTP), i.e. what people are willing to give up in order to obtain one more unit of z_j. Suppose for a moment that z_j is culture. In a cost-benefit analysis, the social marginal benefit, given by (2), is compared to the marginal cost, which is the value of what is given up in order to produce an additional unit of z_j. The efficient level of z_j is achieved when the marginal benefit is equal to marginal cost. It would be inefficient to produce z_j when the marginal benefit is less than the marginal cost. Vice versa, additional units of z_j should be produced as long as marginal benefit exceeds marginal cost. In section 6, we will show how we use the model presented above to determine whether cultural amenities are optimally provided by comparing the amount of public investments in cultural amenities with the estimated benefits associated with them.

Before concluding this theoretical section, it is worth mentioning that the literature on valuing culture is still discussing whether the hedonic pricing method, as well as other economic valuation techniques, are able to capture all dimensions of cultural value (Bakhshi and Throsby, 2010).[4] As regard to this concern, we would point out two aspects supporting our methodology: first, benefits of culture are expressed in a manner that is commensurable with other calls on the public purse (O'Brien, 2010). Second, we aim at further improving the evaluation of culture's benefits developing a measure that accounts for multiple aspects of this amenity, as shown in Section 5.2.

[4] For a dissertation about the value of culture, see Throsby (2001), Bakhshi and Throsby, 2010, and references therein.

4. Empirical Strategy

The empirical strategy adopted in this paper is based on the multilevel approach. Multilevel analysis (Goldstein, 2011; Snijders and Bosker, 1999) is a methodology for the analysis of data with complex patterns of variability. Hierarchical modeling is conveniently carried out by resorting to mixed-effects models, i.e. statistical regression models which incorporate both fixed effects (that are constant across groups), and random effects (that randomly vary across groups). By associating common random effects to observations in the same group, mixed-effects models flexibly represent the covariance structure induced by the grouping of data.

Multilevel models have been employed in several works on the hedonic approach applied to the housing market, where houses are considered as nested in neighborhoods and the analysis is carried out at individual house level and neighborhood level simultaneously (Goodman and Thibodeau, 1998; Orford, 2000 and 2002; Brown and Uyar, 2004; Gelfand et al., 2007). This kind of models allow to dissect group-level and individual-level effects on individual-level outcomes, i.e. the property prices, accounting for the non-independence of observations within groups, i.e. the neighborhoods. A common problem with observations nested within a higher level is that there may be a problem of dependencies because individual properties in the same district are likely to be similar in ways not fully accounted for by the property and district variables included in a single-level model (Jones and Bullen, 1993). Multilevel models allow to accommodate the spatial dependency of the residuals by differentiating between-individual errors from between-neighborhood errors (Orford, 2000). If this dependency is not considered, the standard error estimates turn out to be biased (Snijders and Bosker, 1999).

4.1. Model Specification

We briefly recall the notation introduced in Section 3. City neighborhoods are denoted by n, with

$n = 1, \ldots, N$; housing units are indexed by h, with $h = 1, \ldots, H$. There are H_n housing units in neighborhood n, and $\sum_{n=1}^{N} H_n = H$. The hedonic price equation is specified as a random intercept model as follows:

$$ln(P_{hn}) = \beta_0 + \boldsymbol{\beta}'_1 \boldsymbol{X}_{hn} + \boldsymbol{\beta}'_2 \boldsymbol{Z}_{hn} + A_n + \varepsilon_{hn}, \quad (6)$$

where P_{hn} is the market value of housing unit h in neighborhood n; $\boldsymbol{X}_{hn}$ is a column vector of housing characteristics and $\boldsymbol{Z}_{hn}$ is a column vector of amenities of housing unit *h* in district *n*; A_n is the random intercept representing level 2 (neighborhood specific) residuals. ε_{hn} are level 1 (housing unit specific) residuals. They are assumed to be mutually independent and normally distributed with zero mean and variance equal to σ^2. Level 2 residuals are assumed to be uncorrelated with ε_{hn}, mutually independent and normally distributed with zero mean and variance equal to τ^2. ε_{hn} residual represents the unexplained variability of the (log) selling price of housing units after considering measurable characteristics of the property and the district clustering, whereas A_n residual represents unexplained heterogeneity at the district level. The latter allows to deal with the problem of spatial sorting on unobservable (Gyourko et al., 1999). This occurs when high-quality housing units are located in the best city neighborhoods and the factor determining the high-quality of houses and neighborhoods are unobservable. This point will be returned to Section 5.

It straightforwardly turns out that $Var(log(P_{hn}) \mid \boldsymbol{X},\boldsymbol{Z}) = \sigma^2 + \tau^2$. Hence the overall conditional variability of price can be decomposed in two components due to individual and district heterogeneity. The intraclass correlation coefficients, $\tau^2 / (\sigma^2 + \tau^2)$, represents the proportion of variability due to district clustering and measures the correlation shared by units within a neighborhood.

The model has been estimated by restricted maximum likelihood using the R function `lmer` of library `lme4` (Bates et al. 2015).

In the next two sections we show how urban amenities are measured. The variables we obtain enter in vector $\boldsymbol{Z}_{hn}$ of (6).

5. Data and Variables

In this paper several datasets have been joined together to obtain the information used in the empirical analysis. There are two main sets of data, namely housing market data and amenity data.

Housing market data consists of 3946 housing transactions occurred in Milan between 2004 and 2010. The dataset is provided from the Real Estate Observatory (*Osservatorio del Mercato Immobiliare*),[5] which divides the city of Milan in 55 administrative areas (henceforth neighborhood) on the basis of housing market behavior: the division is such that prices of houses located in the same neighborhood are supposed to move together. Figure A1 in the Appendix shows the 55 neighborhoods.

The dataset is assumed to be representative of the residential housing market. In particular, the sample is taken following a stratified design where strata are neighbourhood and building typology. Inter-municipality homogeneous areas are continuous territorial units where homogeneous prices are expected as a consequence of similar urban, environmental and socio-economic characteristics. Since our paper refers to the Municipality of Milan, only the latter two strata actually matter. A minimum of 10 contracts in a year are selected for each strata.[6]

A simple descriptive analysis presented below shows a great variability of housing prices across neighborhoods. Transaction prices were converted in annual rents by applying a discount rate specific to each neighborhood, as in Andreoli and Michelangeli (2014). The discount rate was determined by dividing the average imputed rent by the average price of housing in the neighborhood, both

[5] http://www.agenziaentrate.gov.it/wps/content/nsilib/nsi/documentazione/omi accessed March 31, 2016.

[6] More details about the monitoring price campaign can be obtained from the manual (in Italian) available at the following link http://www.agenziaentrate.gov.it/wps/file/Nsilib/Nsi/Documentazione/omi/Manuali+e+guide/Il+manuale+della+banca+dati+OMI/Manuale_OMI_luglio2009_rev_logo.pdf

expressed in constant 2010 Euro. Housing units in the sample are spatially identified by the civic address. We geocoded each civic address in the dataset by its UTM coordinates using a Java script that retrieves this information from Google Maps geographical databases. Figure A2 panel *(a)* in the Appendix shows the sample distribution of housing prices; panel *(b)* shows the spatial locations of the housing units included in the sample.

Figure A3 in the Appendix shows the boxplots of housing prices by neighborhood. The distribution is right skewed and the mean value is driven by a few really high values that tend to cluster in some neighbourhoods of the city. A random intercept at the neighbourhood level has been included in our model to estimate a different intercept for each neighbourhood, hence accounting for the spatial heterogeneity. This is why we went for a multilevel approach in the first place. Moreover, modelling prices in the log-scale permits to control for the impact of exceptionally high values on the inference.

In addition to housing market values, the data set provides a detailed description of housing-specific attributes of the sample units, including total floor space, floor level, number of bathrooms, whether the housing unit has independent heating, presence of an elevator or a garage. A more detailed description of these variables is reported in the Appendix. Summary statistics are shown in Table A1 in the Appendix.

We retrieved geo-coded data about amenities from the open data portal of the municipality of Milan.[7] Figure A5 in the Appendix depicts spatial locations of different amenities. In particular, we considered 88 theaters, fig. A5-(*a*), 117 libraries, fig. A5-(*b*), 78 museums, fig. A5-(*c*), 189 auditoria, fig. A5-(*d*), 139 parks fig. A5-(*e*) and 710 university sites, fig. A5-(*f*). The latter figure also shows the stops of the metro lines. Green areas correspond to public parks for which the area is specified in hectares by the municipality of Milan and are spatially located at their centroids. Maps reported in Figure A5 show a clear clustering towards the city center for all the considered amenities, with the exception of parks and university sites. As in Brambilla et al (2013) and Garretsen and Marlet (2016)

[7] dati.comune.milano.it accessed March 31, 2016.

universities are considered as a proxy for education. Unfortunately, we do not have information on other variables for the quality of education, such as the percentage of pupils moving up to a higher class or parameters for classroom and/or building facilities.

5.1. Construction of the amenity covariates

The construction of amenity covariates follows Tobler's (1970) first law of geography stating that '*everything is related to everything else, but near things are more related than distant things*' (Tobler 1970, p. 237). Accordingly, amenities influence housing prices in function of the distance between them and housing units: housing prices decline with distance in the case of an amenity and increase with distance in the case of disamenity. Moreover, housing prices also depend on the quantity and/or size of amenities, positively in case of amenities, negatively in case of disamenites. We use a measure able to catch these two aspects of amenities: their distance from the houses and their size or quantity. The measure is based on the potential accessibility indicator, developed by ESPON (2007) and Osland (2010), and is composed of two functions: the amenity function measuring the size or quantity of amenities, and the impedance function measuring the distance between housing unit and amenity (Wegener et al., 2002). Formally, the variable measuring accessibility of amenity z_j is $\tilde{z}_j$ defined as:[8]

$$\tilde{z}_j = \sum_{s=1}^{S_j} w_{js} \exp(-\gamma\, d_{hjs}), \qquad (7)$$

where S_j is the total number of amenity z_j locations; w_{js} is the amenity function defined below; $\exp(-\gamma\, d_{hjs})$ is a distance decay function, d_{hjs} being the Euclidean distance expressed in meters between housing unit h and amenity z_j located in s.

The amenity function w_{js} for green areas corresponds to their size in hectares. For all the other amenities – metro, theatres, museums, libraries, auditoria – we have not got appropriate amenity dimensions, hence the amenity function has been constantly set to 1 (i.e. $\tilde{z}_j$ is a weighted total of the

[8] To avoid cumbersome notation, in what follows we drop the subscript indicating neighborhood *n*. We also do this below when the context alone suffices to identify the data hierarchy.

amenity in the study areas).

The advantage of using the variable $\tilde{z}_j$ is that it accounts not only for the closest amenity, but also for the farther ones, weighting them according to their distances from housing units. The value of parameter γ affects the "shape" of impedance function and it has been endogenously determined on the basis of the lowest Akaike Information Criterion (AIC) of the estimated regression model. More specifically, the accessibility index in equation (7) was evaluated over a grid of γ values and the log-price was marginally regressed on each of these indices in turns, separately for each amenity. The γ value providing the lowest AIC was retained to build the covariates used in the regression model (6). The γ values obtained are reported in Table 1.

[Insert Table 1, about here]

Figure 1 shows the shape of the impedance function for the two more extreme cases: museums (highest γ value in table 2) and theaters (smallest γ value in table 1). The impedance function gives a smaller weights to an amenity the farther its location to a housing unit, hence when the value of the impedance function gets negligible, the impact of this amenity location vanishes.

In Osland's (2010) work-job accessibility is considered as labor-market opportunity, observing a positive relationship between housing prices and access to labor markets. In our framework the accessibility index in equation (7) will convey information regarding the effects of the surrounding both in term of infrastructural and cultural amenities. A numerical example can clarify this point. Suppose we have a housing unit with three metro stations located at 200 meters, 500 meters and 1000 meters respectively. The estimated γ is equal to 0.0057 (see table 2), hence the potential accessibility is: $\exp(-0.0057\times200)+\exp(-0.0057\times500)+\exp(-0.0057\times1000) = 0.3198+0.0568+0.0033 = 0.3810$. In this case the nearest metro station determines 84% of the value of the indicator whereas the farthest metro station only contributes 1% although all the three stations are encompassed by the index. Setting a conventional distance threshold one can worked out a "radius of influence" of any given amenity i.e. a distance above which the impedance function is virtually 0 implying that the contribution of the corresponding locations is negligible. Using, for example, a threshold equal to 0.02, the radius of influence of the metro stations is 680 meters.

The case of parks is slightly different since we weighted the impedance function by the size of parks. Suppose, as before, that there are three parks located at 200 meters, 500 meters and 1000 meters with a size respectively of 0.6 hectares, 2 hectares and 20 hectares. In this case $\gamma = 0.0085$, and the potential accessibility is:

$\exp(-0.0085\times200)\times0.6+\exp(-0.0085\times500)\times2+\exp(-0.0085\times1000)\times20 = 0.1422$. Interpreting this value is less straightforward than in the previous case since it depends on the number of parks and their size. The radius of influence of the other amenities are summarized in Table 1.

[Insert Figure 1, about here]

As regards effects induced by higher-education institutions on housing prices, we follow a slightly different procedure to measure them. In Milan there are 710 university buildings belonging to seven main institutions and four academies of arts and design.[9] As shown in panel *(f)* of Figure A5, these institutions are not concentrated in some areas but are spread across neighborhoods. Making residence choice, a potential dweller considers the proximity to a specific higher-education institution, rather than to a variety of different institutions because the latter are far from each other. For this reason, we consider the following proximity index defined for housing unit h as $\frac{\max_u(d_{hu})-d_{hu}}{\max_u(d_{hu})}$, where d_{hu} is the distance between the housing unit h and the university site u; the maximum is calculated with respect to all the 710 university sites. The descriptive statistics of amenity covariates are shown in Table A1 in the Appendix.

[9] The seven universities are: Bocconi University; Catholic University of the Sacred Heart; International University of Languages and Media; Milan-Bicocca University; Politechnic of Milan; San Raffaele University; University of Milan. The four academies are: Brera Fine Arts Academy; European Design Institute; New Fine Arts Academy; SAE Institute Milan.

5.2. The Cultural Catalyzer

One of the main challenges of the paper is to construct a variable for cultural amenities able to capture the multiple effects of these amenities mentioned in the Introduction. We start by considering that cultural amenities constitute an element of something, which is hard to measure. We refer to the "cultural environment", generated by a combination of aesthetics factors, styles, rhythms, behaviours. Under this perspective, cultural amenities are important not only *per se*, but also because they contribute to make vibrant a neighbourhood, and perhaps more thoughtful and tolerant. We try to capture all these positive aspects by proposing a new measure for cultural amenities named Cultural Catalyzer. The name is inspired to the terminology used by New Jersey Governor Tom Kean who in 1909 referred to Newark Museum and other urban cultural assets as "catalysts of rebirth" (Strom, 2002). In this paper, the Cultural Catalyzer is a composite indicator of cultural amenities available in our dataset: theatres, museums, libraries and auditoria. If the cultural amenities are more or less next to each other, they form a bundle that will be able to affect housing prices differently from each cultural amenity separately considered. We name this effect the "compositional effect power" and we aim at measuring it using the Cultural Catalyzer.

To obtain the Cultural Catalyzer, we first construct the accessibility index for the four cultural amenities according to equation (7). The accessibility indexes turn out to be moderately correlated to each other, the correlation coefficients ranging between 0.29 and 0.47. Hence, a natural way to get a unique variable out of them it is to resort to a principal component (PC) analysis. More specifically, we performed a PC analysis via a singular value decomposition of the correlation matrix of the four accessibility indexes. Only the largest eigenvalue has been found significantly larger than 1, whereas the others have values ranging from 0.73 to 0.43. The first PC alone explained more than 50% of the total inertia, whereas the others explained the same minor proportion of the total variability. Then, the first PC has been used as a synthetic indicator of cultural amenities and named Cultural Catalyzer in the paper. Using the first PC has also the advantage to reduce multicollinearity in the linear predictor of the regression model assuring more stability to the numerical procedures used in model fitting and avoiding, at the same time, to subset the amenities set that can lead to lose or underestimate their network effect on housing prices. The loadings of the first PC are: 0.50 (theatres), 0.50 (museums), 0.55 (libraries) and 0.45 (auditoria). Since these values are quite similar, the four typologies of cultural amenities are equally represented by the cultural catalyzer.

Figure 2 shows the spatial dynamics of the cultural catalyzer predicted across the city. The map reveals how larger values are expected towards the city centre. To spatialize the catalyzer a regular grid of 1138 points has been created within the boundary of Milan municipality provided by a shapefile. For each of these points the accessibility index in equation (7) has been calculated with respect to the locations of the four cultural amenities mentioned above obtaining a 1138×4 matrix. The first PC has been predicted by multiplying this matrix by the first eigenvector of the correlation matrix. Figure 2 has been obtained by rasterizing the grid.

[Insert Figure 2, about here]

6. Results

In this section the regression results are presented. The covariates entered in the model by block, as shown in Table 2. Model 1 includes the constant term and the intercept random term; Model 2 adds the group of time fixed effects; model 3 adds housing specific characteristics; model 4 also considers amenities other than the cultural catalyzer and model 5 includes the cultural catalyzer. The overall housing (log)-price variability is estimated as big as 0.4423 by Model 1. 57 per cent of this variability is due to neighborhoods' factors, whereas 43 per cent is explained by housing-specific factors. Adding variables to the baseline model 1, the variance of random effects decreases of more than an half, meaning that the additional explanatory variables are able to explain a relevant portion of variability in log price. More specifically, housing-specific characteristics decreases unexplained variability of

50.1 per cent; urban amenities reduce unexplained variability of 13.6 per cent; and the cultural catalyzer further reduces variability of 11.3 per cent. The estimated final model fits data reasonably well with an R^2 value between observed and predicted log-prices equal to 0.86. As it can be noticed, all covariates act in a priori predictable way. Focusing on amenities variables, they are all significant at different levels. Proximity to university, parks and metros positively contribute to determine the equilibrium housing price. The estimated coefficients associated with the polynomial term for the cultural catalyzer indicate that the impact of culture is increasing at a decreasing rate. This means that cultural amenities have a stronger positive effect when they are few or less accessible and their effect reduces if their quantity increases or they become more accessible. We finally note that amenities tend to cluster in the central part of the city, hence measuring the distance between housing unit and each of the amenities might include a "centre effect" that could be controlled entering the distance from the city centre as covariate. We ran a regression including the distance between housing unit and the Milan Cathedral, which is located downtown, in the linear predictor. However, such a distance turned out to be statistically not significant (p-value=0.82). Moreover, entering this distance in the model did not substantially alter the value of the other estimates. We then excluded it from the model specification.

[Insert Table 2, about here]

The hedonic prices or marginal willingness to pay (MWTP) associated with urban amenities are reported in Table 3.[10] As shown in Section 2, they correspond to the partial derivative of the estimated hedonic price function. To calculate the derivative, first the estimated expected price is obtained by equation (6). However, since the log transformation of the prices under the Gaussian assumption of the residuals has been considered, the relation between the normal and the lognormal distribution has to be taken into account for deriving appropriate estimates. The following results from the normal distribution are used. If Y is a normally distributed random variable with expected value μ and

[10] Hedonic prices for housing-specific characteristics can be provided upon request.

variance ϑ^2, $P = \exp(Y)$ is lognormally distributed with expected value equal to $\exp(\mu + \vartheta^2/2)$. The multilevel regression model in equation (6) provides the estimate of μ conditional on the values of the covariates on the log scale and the estimates of the two additive components, σ^2 and τ^2, of ϑ^2. Hence, the expected value of the price has been obtained by plugging in the estimated values in the previous formulas.

In order to compare the relative size of the effects of different amenities, the hedonic prices are computed considering a marginal variation in the corresponding amenity equal to 1 standard deviation, keeping all the other covariates at the average sample quantities.

[Insert Table 3, about here]

The hedonic price associated with Cultural Catalyzer indicates that households are, on average, willing to pay €225 per year for a marginal increase of the cultural catalyzer. This result is consistent with the figures of a study from the Milan Chamber of Commerce (2012), showing that in 2011 city's households on spent €164 per month in cultural and leisure activities, corresponding to an yearly amount of €1968. Milan turns out to be the fifth Italian city for expenditures in cultural and leisure activities.

Table 4 shows the estimation results of model (6) where the Cultural Catalyzer components are introduced separately.[11] All the filter components are statistically significant at 0.01 level, with the exception of theaters, which are significant at 0.1 level. Accessibility indexes for museums and auditoria admit a polynomial term implying nonlinear effects on housing log-prices. According the hedonic price associated with each component, the accessibility index for museum is the most important component of the Cultural Catalyzer (€889), followed by auditoria (€502), libraries (€297), and theatres (€200).

[Insert Table 4, about here]

It is worth emphasizing two further results. The first one concerns the intercept random term, whose

[11] The complete estimation results for each specification are available upon request.

estimates, based on model 5, are reported in Figure 3. Substantial variations can be observed across neighborhoods, the intercept term varies between -0.4274 and 0.9324 and the standard deviation is equal to 0.3103. The positive values mainly refer to neighborhoods located in the city centre, while negative values are rather in the outlying neighborhoods. This term allows to handle the problem of the spatial sorting mentioned in Section 4.

[Insert Figure 3, about here]

The second comment concerns the MWTPs calculated by neighborhood for each amenity, and reported in Figure 4. MWTPs tend to be higher in the city centre and lower in the neighborhoods far from the city centre. This is consistent with the positive sorting in which households with high MWTP avoid poor-endowed neighborhoods to live in the best-endowed amenities.

[Insert Figure 4, about here]

We use equation (5) to compute the social benefit associated with a marginal increase in the cultural catalyzer. As shown in Section 3, the social benefit is obtained summing up the MWTP over the number of households given by the city's housing units owned by residents and that are on average equal to 604,510 in the period 2004-2010. This procedure has been used in the literature to obtain the social marginal value of public goods, especially of environmental nature (see, for example, Chay and Greenstone, 2005). It implicitly assumes a constant number of people in each household (Smith and Huang, 1995). The estimation of the social benefit, equal to 136million Euro, is compared to the annual investments in culture that amount to about 35million Euro over the same period.[12] The benefits-to-costs ratio is about 3.88. Koster and Rouwendal (2016) find benefits-to-costs ratios between 3.64 and 4.28 for Dutch historic amenities. This results provide evidence that investments in cultural amenities, in our case, and in historical amenities, in Koster and Rouwendal (2016), generate positive effects to society. Moreover, a benefit-to-cost ratio bigger than 1 implies that the municipality

[12] The municipality balance sheet and relative income and expenditure items are available on line http://www.openbilanci.it Accessed March 31, 2016.

of Milan allocates too few resources to culture with respect to the expected benefits.

7. Conclusion

This paper is an original attempt to evaluate the social marginal value of cultural amenities in a city by proposing a new measure, named Cultural Catalyzer, which captures the joint effect of cultural amenities on housing market values. Cultural Catalyzer and variables measuring the effect of the other urban amenities considered in our analysis are constructed in such a way as to take explicitly into account both the distance of amenities from houses and the amenity size and quantity.

Our empirical investigation for Milan indicates that public investments in cultural amenities are modest relative to the estimation of the benefits. We might wonder how and by whom culture should be financed. Baumol and Bowen (1966) argue that cultural amenities benefit the community as a whole and, for this reason, they may be thought as local public goods. Consequently, culture should be financed by taxes. A second argument in favor of local public found relies on previous studies, such as Falck et al. (2015), providing empirical evidence that local economic activities benefit from the presence of cultural amenities.

Some caveats are worth mentioning. First, the paper provides an evaluation of the social marginal benefits of culture without identifying the mechanisms through which culture increases households' utility. The latter issue is beyond the aims of this work. Second, the theoretical framework is developed focusing on a single city, although our methodology could be applied to compare the effect of culture in different cities or in greater geographical areas, such as regions. In this case, the theoretical framework should be extended in a general equilibrium setting by considering the labour market in addition to the housing market. These two markets are interconnected and both contribute to determining the full implicit price of amenities, obtained by the sum of the housing price differential and the negative of the wage price differential.

References

Andreoli, F.,& Michelangeli, A. (2014). Welfare Measures to Assess Urban Quality of Life. Working Paper n. 278, University of Milano-Bicocca, Department of Economics.

Andreoli, F.,and Michelangeli, A. (2015). The hedonic value of urban quality of life. In Michelangeli, A. (ed.) Quality of Life in Cities: Equity, Sustainable Development and Happiness from a Policy Perspective, Routledge, Series: Routledge Advances in Regional Economics, Science and Policy 2015.

Bakhshi, H. and Throsby, D. (2010) Culture of Innovation: An economic analysis of innovation in arts and cultural organisations. London: NESTA.

Bartik, T. J. & Smith, V. K. (1987). Urban amenities and public policy. In: E. S. Mills (Ed.). Handbook of Regional and Urban Economics, Vol. II (pp. 1207–1254). Amsterdam: NorthHolland.

Bates, D., Maechler, M., Bolker, B. & Walker, S., (2015), Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software, 67(1), 1-48.

Baumol, W. & Bowen W. (1966). Performing Arts, The Economic Dilemma: a study of problems common to theater, opera, music, and dance. New York: Twentieth Century Fund.

Blomquist, G. C. (2006) Measuring quality of life, in: R. J. Arnott and D. P. McMillen (Eds.). A Companion to Urban Economics (pp. 479–482). Oxford: Blackwell Publishing.

Boualam, B. (2014). Does culture affect local productivity and urban amenities? Regional Science and Urban Economics, 46, 12-17.

Brambilla, M., Michelangeli, A. & Peluso, E. (2013). Equity in the city: On measuring urban (ine)quality of life. Urban Studies, 50, 3205-3224.

O’Brien, D. (2010). Measuring the Value of Culture: A Report to the Department for Culture Media and Sport. London: Department for Culture, Media and Sport.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/77933/measuring-the-value-culture-report.pdf

Brown, K.H. & Uyar, B. (2004). A hierarchical linear model approach for assessing the effects of house and neighborhood characteristics on housing prices. Journal of Real Estate Practice and Education, 7(1), 15-23.

Clark, T. N. (2003). Urban Amenities: Lakes, Opera, and Juice Bars: Do They Drive Development? In T. N. Clark (Ed.), The City as an Entertainment Machine. Research in Urban Policy (pp.103-140). Emerald Group Publishing Limited.

Clark, D.E. and Kahn, J.R. (1988). The social benefits of urban cultural amenities. Journal of Regional Science, 28, 363-377.

ESPON (2007). Update of selected potential accessibility indicators (Final report). Dortmund, Spiekermann & Wegener: http://www.espon.eu/export/sites/default/Documents/Projects/ESPON2006Projects/ScientificBriefingNetworking/UpdateOnAccessibilityMaps/espon_accessibility_update_2006_fr_070207.pdf

European Commission (2007). First-ever European strategy for culture: contributing to economic growth and intercultural understanding. IP/07/646 Brussels, European Commission.

European Commission (2014). Report on the role of public arts and cultural institutions in the promotion of cultural diversity and intercultural dialogue. Brussels, European Commission.

Falck, O., Fritsch, M., Heblich, S. & Otto, A. (2015). Music in the Air: Estimating the Social Return to Cultural Amenities, CESifo Working Paper No. 5183.

Florida, R. (2002a). Bohemia and Economic Geography. Journal of Economic Geography, 2, 55-71.

Florida, R. (2002b). The Rise of the Creative Class and How it is Transforming Work, Leisure, Community and Everyday Life. New York: Basic Books.

Florida, R. (2005). Cities and the Creative Class. New York: Routledge.

Garretsen, H. & Marlet, G. (2017). Amenities and the attraction of Dutch cities. Regional Studies, 51(5), 724-736.

Gelfand, A.E., Banerjeeb, S., Sirmans, C.F., Tu, Y. & Ong, S.E. (2007). Multilevel modeling using spatial processes: Application to the Singapore housing market. Computational Statistics & Data Analysis, 51, 3567-3579.

Glaeser, E. L., Kolko, J. & Saiz, A. (2001). Consumer City. Journal of Economic Geography, 1(1), 27-50.

Glaeser, E. L. (2009). The Death and Life of Cities. In R. P. Inman (Ed.) Making Cities Work: Prospects and Policies for Urban America (pp. 22-62). Princeton University Press.

Goldstein, H. (2011) *Multilevel statistical models*, Chichester, Wiley.

Goodman, A.C., & Thibodeau, T.G. (1998). Housing market segmentation. Journal of Housing Economics, 7, 121-143.

Gravel, N., Michelangeli, A., & Trannoy, A. (2006). Measuring the social value of local public goods: An Empirical Analyis within Paris Metropolitan Area. Applied Economics, 38, 1945-1961.

Gyourko, J., Kahn, M. & Tracy, J. (1991). The structure of local public finance and the quality of life. Journal of Political Economy, 99(4), 774-886.

Gyourko, J., Kahn, M. & Tracy, J. (1999). Quality of life and environmental comparisons. In:P. C. Cheshire & E. S. Mills (Eds.) Handbook of Regional and Urban Economics (pp. 1413–1454). Amsterdam: Elsevier.

Italian Department for Development and Social Cohesion (2013). I flussi finanziari pubblici nel settore Cultura e Servizi Ricreativi ITALIA. DPS: Rome.

Jones, K. & Bullen, N. I. (1993). A multilevel analysis of the variations in domestic property prices: southern England, 1980–87. Urban Studies, 30, 1409–1426.

Koster, H.R.A. & Rouwendal, J. (2016). Historic Amenities and Housing Externalities: Evidence from the Netherlands. Economic Journal, forthcoming.

Lazrak, F. Nijkamp, P., Rietveld, P. & Rouwendal, J. (2014). The market value of cultural heritage in urban areas: an application of spatial hedonic pricing. Journal of Geographical Systems, 16, 89-114.

Milan Chamber of Commerce (2012). Indagine sui consumi delle famiglie nel commune di Milano. http://www3.mi.camcom.it/files/indagine/RapportoConsumi2011.pdf last access 17-01-2017.

Montalto V; Jorge Tacao Moura C; Langedijk S; Saisana M. The Cultural and Creative Cities Monitor. 2017 Edition. doi: 10.2760/031627

Moro, M., Mayor, K., Lyons, S. & Tol, R.S.J. (2013). Does the Housing Market Reflect Cultural Heritage? A Case Study of Greater Dublin. Environment and Planning A, 45, 2884-2903.

Osland L. (2010). Spatial variation in job accessibility and gender: an intraregional analysis using hedonic house-price estimation. Environment and Planning A, 42, 2220-2237.

Orford, S. (2000). Modelling spatial structures in local housing market dynamics: A multilevel perspective. Urban Studies, 37(9), 1643-1671.

Orford, S. (2002) “Valuing locational externalities: A GIS and multilevel modelling approach”, Environment and Planning B: Planning and Design, 29(1), 105-127.

Russo, A. P. & Van der Borg, J. (2010) “An Urban Policy Framework for Culture Oriented Economic Development: Lessons from Netherlands”, Urban Geography, 31, 668-690.

Sheppard, S. (2013). Museums in the neighborhood: the local economic impact of museums. In Giarratani, F. and Hewings, G.J.D., and McCann, P. (Eds) Handbook of Industry Studies and Economic Geography, ch. 7, 191-204.

Snijders, T. A.B. and Bosker, R.J. (1999). Multilevel Analysis, Sage, London.

Strom, E. (2002). Converting pork into porcelain: Cultural Institutions and Downtown

Development. Urban Affairs Review, 38, 3-21.

Tobler, W. (1970) “A computer movie simulating urban growth in the Detroit region”, *Economic Geography*, 46(2), 234-240.

Throsby, D. (2001). Economics and Culture. Cambridge University Press, New York.