Italian Economic Journal
https://doi.org/10.1007/s40797-024-00270-w

RESEARCH PAPER

Better Late than Never: Promoting Cultural Consumption Among the Elderly

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Received: 15 September 2023 / Accepted: 12 February 2024

Abstract

Cultural activities are greatly beneficial to older individuals but, unfortunately, many still face significant barriers that limit their ability to enjoy the arts. To tackle this issue, we have analysed data from an Italian audience development and engagement program for seniors, which was implemented at local level. By using an agent-based model, we discuss the potential effectiveness of audience development policies before implementation. Our research shows that social policies aimed at promoting cohesion and creating personal relationships can significantly increase the success of such initiatives. Moreover, our findings underline the importance of implementing targeted policies and engaging key individuals to ensure that older people can access and enjoy cultural activities.

Keywords Elderly · Museum pass · Engagement policies · Agent-based model

JEL Classification Z1 · C69

1 Introduction

With rapid population ageing, the well-being of those aged 60 and above has become a focal point for private and public policies. Creative and cultural participation play a vital role in promoting social cohesion, inclusion, and the accumulation of social

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Published online: 05 March 2024

capital among the elderly (Belfiore 2002; Ferraro et al. 2019) and significantly contribute to the reduction of the risk of depression (Ghenta et al. 2022). Grossi et al. (2011) analysed the social dimension of cultural activities and found that collective participation motivates older people to engage in activities that they would not typically practice otherwise. McLean et al. (2011) surveyed 31 studies on people over 60, mostly based in the UK and USA, and concluded that participatory art programs provide opportunities for social contacts, friendship, and support within the art groups themselves. In general, cultural participation improves the well-being of older people and counteracts the negative effects of ageing. Noice et al. (2014) reviewed the benefits and challenges of participatory arts for older adults and highlighted the importance of dance, expressing writing, music, theatre arts, and visual arts in improving their quality of life. Archer et al. (2018) examined a spectrum of 40 different factors that could potentially contribute to overall well-being. Among these factors, which encompassed elements like physical activity and community group affiliations, cultural participation emerged as the paramount influencer, as established by their findings. Building on this, Fancourt and Steptoe (2019) delved into the outcomes of the ELSA study (English Longitudinal Study of Ageing). This longitudinal investigation, involving over 6000 adults aged 50 years in England, started in 2004–5 and spanned a remarkable 14-year follow-up period. The findings showed that individuals engaging in artistic activities exhibited a 31 percent reduced risk of mortality, which reduced to 14 percent for people engaged in art activities on infrequent basis. The correlation between art engagement and elevated levels of well-being has been recently scrutinized in a study by Tymoszuk et al. (2021). Their investigation involved 5338 adults in the UK during 2018–2019, encompassing various forms of artistic engagement such as literary, visual, performing, crafts, and decorative arts and suggests that distinct attributes of engagement might hold implications for mental and social well-being.

Although cultural access and participation are vital, significant portion of the elderly population is unable to engage with the arts due to various barriers. Keaney and Oskala (2007) identified poor health, inadequate social networks, and limited transportation access as significant impediments to cultural access among individuals aged 55 and above. Additionally, Goulding (2018) pointed out the importance of the vicious circle that cultural participation perpetuates by both reflecting and creating inequality of opportunities in later life. Cultural engagement reveals the impact of class, gender, and ethnicity on engagement contexts and subsequent outcomes.

The aim of this paper is to contribute to the ongoing debate on promoting cultural access to improve the well-being of the elderly. Specifically, we focus on museum consumption among the elderly population, being museums a vital cultural and social space for active ageing (Hérnandez Lara and Toney 2021), which prevents reduced physical activity and its related consequences in later life (Palmer et al. 2019). Extant literature has also shown that elderly individuals are enthusiastic about visiting museums (Rogers 1998; Tufts and Milne 1999), and age-friendly environments play a significant role in supporting active ageing (Officer et al. 2017) and reducing the elderly's isolation, that often leads to depression and cognitive impairment (Lubben 2017).

In this study, we use data from an audience and engagement initiative, supported by an Italian philanthropic foundation, to examine the effectiveness of standard price and education interventions in increasing museum consumption among the elderly. The initiative involved a representative sample of individuals aged 60 and above, who attended five public leisure centres in Turin, the main city of Piedmont region (North-West of Italy). Participants were offered a free trial annual museum pass (Abbonamento Musei, AM) and a program of monthly museum visits. After the free trial has expired, they could renew their museum passes through a priced subscription.

The AM stands as an annual museum membership card, extending complimentary entry to all museums, royal residences, castles, and temporary exhibitions within Turin, Piedmont, and Valle d'Aosta. Priced at 48 euros in 2018, the AM card distinguishes itself from conventional tourist cards or major museum memberships through its distinct focus on target demographic, duration, scope, and associated incentives. Rather than catering primarily to tourists, the card is targeted to residents, bearing a one-year validity and conferring unrestricted admission to a comprehensive array of city museums encompassing both state-run and private-institutions.

While certain annual museum passes (e.g. the Netherlands Museum Pass Museumkaart) are designed specifically for residents and are not actively marketed to tourists, the majority of tourist cards tend to be valid for a restricted period, averaging up to 3 days. In contrast, membership cards typically grant admission to a single museum, or, in some cases, a small cluster of museums united under a common ownership (such as civic museums, state museums, or those affiliated with the same cultural foundation).[1] Frequently, the AM offers access to modest discounts (up to a maximum of 10 percent) for participation in various cultural events, exhibitions, and museums. Notably, unlike tourist cards, the AM card does not extend its discounts to transportation, restaurants, or regular retail shops.

In what follows we employ the renewal rate of AM to gauge the efficacy of the audience development and engagement policy. To elucidate the factors influencing the renewal decision and to explore the potential channels that may enhance such decisions, we constructed an agent-based model. This modeling approach provides a flexible and powerful way to study social behaviors and systems, especially where interactions among persons matter (Steinbacher et al. 2021).

Agent-based models are strongly micro-founded and study economic dynamics as the emergent result that originates from the uncoordinated sequence of interrelated individual choices, thus allowing the modeler to define behavioral rules, constraints, and context configurations without predetermining the result of the investigation (Klügl and Bazzan 2012). Moreover, the heterogeneity of individuals can be fully exploited and the realism of the model is preserved since decisions of agents follow a temporal development which is not coordinated, giving rise to feedbacks influencing each other (Janssen 2005). A typical advantage of this class of models is the possibility to adopt network configurations resembling social ties (Alfarano and Milaković 2009; Schweitzer et al. 2009). As underlined by Dawid and Neugart (2011), agent-based models offer a large toolbox that allows the modeler to deal with policy problems, in particular when agents can be modelled to assume features and behavioral rules based on evidence from either empirical data or the observed reality. Agent-based models can reveal particularly effective when studying the effects caused by changes in the

[1] Refer to Table 6 in the appendix for the characteristics of some European Museum Pass programmes.

policy parameters (Bargigli and Tedeschi 2013). Our aim is to build a community of fictitious agents replicating the personal features of all participants to the community of respondents and measure the impact of some policy initiative. Therefore, we firstly calibrated the model by means of collected data, thus replicating the registered real number of renewals; then, we simulated how results would differ in response to treatment interventions.

Conventional methods used to evaluate public policies primarily estimate their impact (OECD 2020) by means of econometric techniques. Instead, our model analyzes the behavior of simulated agents, which were designed to mirror interviewed persons in the sample and assess the impact of policy hypotheses by referring to the individual likelihood of renewal as a function of personal preferences intertwined with subjective attributes, expert/cultural capital, and networks of social ties.

The data used for calibration were collected through a questionnaire that incorporated validated ISTAT questionnaires to capture the most significant characteristics of cultural consumers and consumption. The information on renewals were sourced from the administrative database on sales of the AM association. Based on this calibration, we tested different potential enhancements to standard price and education audience development policies. In our model, we refrain from constructing a consumption theory designed to extract individuals' willingness to pay for cultural goods relative to other commodities. Consequently, this paper does not explore pricing strategies. Rather, the cost of the renewal, along with pricing decisions, is considered as an exogenously determined parameter since it is completely out of control of our investigation.

Results show that promoting social connections among people is crucial in encouraging the elderly to renew their museum passes. Indeed, individuals with a relevant centrality in the network due to their large number of contacts, play a critical role in terms of a "positive contagion mechanism", thus increasing the likelihood that the elderly access to cultural consumption. These effects are well known in literature describing how social interaction can foster cultural consumption, as in Jafari et al. (2013), Halkier (2020), and Lim et al. (2023), among many others.

The remainder of the paper is organized as follows. Section 2 provides an overview of the data collected by the 'Il quartiere al Museo' program on which this study is based. Sect. 3 outlines the model, encompassing the calibration of the agent-based model, along with the simulation of two potential policies. This entails a comparison between decentralized and centralized engagement strategies, as well as the determination of the most effective catalyst for potential engagement initiatives. Concluding remarks are presented in Sect. 4.

2 Data

The data for this study comes from a project initiated in 2018 and entitled 'Il quartiere al Museo'. It was addressed to the most economically challenged districts of Turin, the regional capital of Piedmont in North-West Italy. The project, developed with the collaboration of 'Abbonamento Musei' (AM), a local public–private foundation entrusted with the advancement of museum activities in Turin, received financial backing from the local philanthropic organization, Fondazione Compagnia di San Paolo

(FCSP), which lends its support to culture, social policies, and research within the region. In 2018, a thousand annual museum passes were allocated to individuals aged 60 or above, actively engaged in activities hosted by five district public leisure centers in Turin, referred to as 'Case del Quartiere' (CdQ). In collaboration, CdQ and AM organized a series of monthly excursions to prominent museums within the regional vicinity. The museum pass extended access to all Piedmont regional district museums for a full year. To qualify for this initiative, participants must not have possessed a museum pass within the preceding two years, with priority granted to those with lower income. After the 12-month trial period, participants were invited to convert their museum passes to paid subscriptions. Our paper deals with the count of paid subscriptions as a metric to gauge the efficacy of the initiative in fostering and stimulating conscious cultural engagement. Before participating to the program, a cohort of participants (N = 837) underwent profiling via a comprehensive questionnaire. To discern patterns in cultural consumption, the questionnaire incorporated the very same inquiries featured in the annual official survey on Italian households by the Italian Institute of Statistics (ISTAT). This approach guarantees the inclusion of the most pertinent attributes of cultural consumers and facets of cultural engagement, while also mitigating potential errors stemming from respondents' misinterpretations of the questions.

For our analysis, we select a subset of the most relevant questions, focusing on personal characteristics such as age, gender, and health status, as well as cultural attributes, such as education level, frequency of attending cultural activities, and reading habits.

Furthermore, interviewed individuals underwent an assessment of their familiarity with renowned cultural works. As an illustration, they were presented with a roster of artists and tasked with identifying the sculptors (among Ligabue, Pomodoro, Merz, Caravaggio, and Rembrandt). They were also asked to identify the painter of "The Scream" (among Picasso, Munch, Michelangelo, Warhol, and Monet), and to name the city in which Michelangelo's Pietà sculpture is located (among Paris, Rome, Florence, London, New York).

To assess participants' proclivity for networking, we examined their involvement in courses and voluntary endeavors. Additionally, we sourced data from the administrative datasets of leisure centers and Abbonamento Musei. This allowed us to capture details about participants' engagement in group museum excursions and the rates of museum pass renewals upon the culmination of the initiative. Descriptive statistics are reported in Table 1.

Out of the sample, approximately 36 percent are male. The age distribution among participants is nearly even, although there are a slightly higher proportion of individuals aged 65–69 and a slightly lower proportion of those aged 80 or above. This distribution of ages could potentially be attributed to an initial self-selection mechanism influenced by individuals' perceived capacity to partake in scheduled activities. Correspondingly, a substantial portion of participants indicated their health status as either good or very good, with a mere 16 percent reporting poor or very poor health. Regarding educational attainment, the predominant segment of the sample possessed primary or early secondary education, accounting for 65 percent. Those with a high-school diploma or university degree are 23 percent and 8 percent, respectively. These

Table 1 Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Male	837	0.36	0.48	0.00	1.00
60–64	837	0.21	0.40	0.00	1.00
65–69	837	0.27	0.45	0.00	1.00
70–74	837	0.24	0.42	0.00	1.00
75–79	837	0.19	0.39	0.00	1.00
80–84	837	0.08	0.27	0.00	1.00
> 84	837	0.02	0.13	0.00	1.00
Heath status: very bad	837	0.03	0.18	0.00	1.00
Heath status: bad	837	0.13	0.34	0.00	1.00
Heath status: fair	837	0.28	0.45	0.00	1.00
Heath status: good	837	0.40	0.49	0.00	1.00
Heath status: very good	837	0.10	0.31	0.00	1.00
Heath status: I don't know	837	0.05	0.22	0.00	1.00
Education: none	837	0.01	0.10	0.00	1.00
Education: primary school	837	0.22	0.42	0.00	1.00
Education: early secondary school	837	0.43	0.50	0.00	1.00
Education: secondary school	837	0.23	0.42	0.00	1.00
Education: university	837	0.08	0.26	0.00	1.00
Education: I don't know	837	0.03	0.16	0.00	1.00
Museum attendance: never	837	0.38	0.48	0.00	1.00
Museum attendance: sometimes	837	0.31	0.46	0.00	1.00
Museum attendance: often	837	0.25	0.43	0.00	1.00
Museum attendance: very often	837	0.03	0.17	0.00	1.00
Museum attendance: I don't know	837	0.04	0.20	0.00	1.00
Movie attendance: never	837	0.40	0.49	0.00	1.00
Movie attendance: sometimes	837	0.31	0.46	0.00	1.00
Movie attendance: often	837	0.21	0.41	0.00	1.00
Movie attendance: very often	837	0.04	0.19	0.00	1.00
Movie attendance: I don't know	837	0.04	0.19	0.00	1.00
Reading: never	837	0.20	0.40	0.00	1.00
Reading: sometimes	837	0.23	0.42	0.00	1.00
Reading: often	837	0.34	0.47	0.00	1.00
Reading: very often	837	0.20	0.40	0.00	1.00
Movie attendance: I don't know	837	0.03	0.18	0.00	1.00
Test score: 0 out of 3	837	0.85	0.36	0.00	1.00
Test score: 1 out of 3	837	0.12	0.33	0.00	1.00
Test score: 2 out of 3	837	0.02	0.15	0.00	1.00

Table 1 (continued)

Variable	Obs	Mean	Std. dev.	Min	Max
Test score: 3 out of 3	837	0.00	0.05	0.00	1.00
Course attendance: never	837	0.56	0.50	0.00	1.00
Course attendance: sometimes	837	0.11	0.31	0.00	1.00
Course attendance: often	837	0.24	0.43	0.00	1.00
Course attendance: very often	837	0.06	0.23	0.00	1.00
Course attendance: I don't know	837	0.04	0.19	0.00	1.00
Volunteering: never	837	0.60	0.49	0.00	1.00
Volunteering: sometimes	837	0.12	0.33	0.00	1.00
Volunteering: often	837	0.14	0.35	0.00	1.00
Volunteering: very often	837	0.10	0.30	0.00	1.00
Volunteering: I don't know	837	0.04	0.19	0.00	1.00
Participating in visits	837	0.67	0.47	0.00	1.00
Museum cards renewed	837	0.53	0.50	0.00	1.00

proportions mirror the distribution within the wider population (8 percent among the 65 + age group at the national level, ISTAT 2021).

As previously mentioned, the study assessed participants' expertise in the art domain by asking them to identify three famous artworks. Only 0.27 percent of the sample scored three out of three correct answers and were considered "experts". Approximately 2 percent scored two out of three, while 12 percent and 85 percent scored one or zero out of three, respectively. Participants were mostly people who do not participate much in cultural activities. The majority of them either never or only seldom visited museums or attended the cinema and theatre. Reading was instead a more widespread activity. Moreover, participants were weakly involved in social activities: approximately 60 percent of participants did not attend courses or engage in volunteering and this evidence is likely to hide poor social networks. Lastly, concerning involvement in the initiative, our observations revealed that around 67 percent of participants engaged in at least one scheduled visit (attendance was consistent across the various locations) with more than half of the participants who chose to extend their museum card at a reduced cost at the end of the project.

3 The Model

To explore effective strategies for devising engagement policies tailored to the elderly, we employ an agent-based model. Our research centers on a population of 837 fictitious agents, each serving as a representation of an actual participant from the 'Il quartiere al Museo' project. Firstly, we endow each agent with a set of individual variables corresponding to the personal values previously detailed in the questionnaires and used to compute the individual likelihood of renewing the museum pass, thus aiming to mirror the same renewal patterns as those observed in the authentic sample, i.e., 442 renewals. Calibration values, derived from Monte Carlo simulations, are then employed to simulate the repercussions, in terms of renewal rates, of various strategies.[2]

3.1 Calibration

In what follows, we operate under the assumption that the probability of renewal for each agent is computed as the average of two constituent components: the agent's individual attributes $\left(\phi_{i,1}\right)$ and the agent's cultural attributes $\left(\phi_{i,2}\right)$, formulated as follows:

$$\pi_i = \frac{1}{2}\left(\phi_{i,1} + \phi_{i,2}\right) \tag{1}$$

For the computation of the first component, i.e., the individual one, we incorporate personal factors encompassing age, health status, and gender, extracted from the questionnaire. Age and health status capture the existence of physical impairments to cultural consumption that, in turn, explains a reduced rate of renewals (Ghenta et al. 2022). The gender parameter is included to capture the observed higher propensity of women to consume culture (Kang 2010). This first component is computed as:

$$\phi_{i,1} = \alpha_1\left(1 - \frac{a_i}{6}\right) + \alpha_2\frac{h_i}{5} + \alpha_3 g_i \tag{2}$$

where $a_i \epsilon [1, 6]$ is the age class; $h_i \epsilon [1, 5]$ is the self-assessment of the agent i's health status; and g_i is equal to 0.49 if agent i is male and 0.51 otherwise.[3] Parametersα_j, $j = 1, 2, 3$, are the weights associated to each variable, and their values will be explained in detail below.

The second component influencing agents' probability of renewal is closely tied to their cultural attributes or what can be referred to as their cultural capital. This concept is captured by several key factors: the individual's educational attainment, denoted as $d_i \epsilon [1, 4]$, the proficiency in the domain of art, $e_i \epsilon [1, 3]$, which is gauged by the aptitude in recognizing cultural artifacts; and lastly, the historical patterns of cultural consumption, which are observed prior to the initiation of the program. To capture the spectrum of cultural consumption, we employ three distinct indicators: $m_i \epsilon [1, 4]$, which reflects self-reported frequency of museum visits; $b_i \epsilon [1, 4]$, which denotes engagement with books; and $c_i \epsilon [1, 4]$, which signifies involvement with movies. This array of indicators collectively paints a comprehensive picture of an individual's cultural consumption

2 In the appendix, we integrate our analysis with standard econometric techniques to estimate a fundamental reduced-form model elucidating the decision to renew the Museum Card upon program completion. The results consistently validate the influence of various variables on renewals and underscore the validity of employing an agent-based model in order to focus on interactions among agents and their effects on renewal decisions.

3 The effect of gender on cultural consumption is likely to become somewhat weaker when considering a broader spectrum of cultural activities across different countries (Falk and Katz-Gerro 2016). To account for this, we model a "low" gap between the male and female parameters.

habits. It is noteworthy that official data from ISTAT (2021) validates the prominence of reading, cinema, and museum visits as the prevailing cultural pursuits among Italians. Moreover, scholarly literature has firmly established that activities such as reading, attending museums, and consuming cinema content constitute pivotal dimensions of cultural engagement. These activities exhibit a strong correlation with the participation in various cultural events like theater performances, visits to cultural sites, and attendance at concerts, as evidenced by studies conducted by Ateca-Amestoy et al. (2008) and Wright (2016). Thus, the second component of the individual renewal probability is computed as:

$$\phi_{i,2} = \beta_1\left(1 - \frac{1}{d_i}\right) + \beta_2\frac{e_i}{3} + \beta_3\frac{m_i + b_i + c_i}{12} \tag{3}$$

where parametersβ_j, $j = 1, 2, 3$, are the weights associated to each variable, and their values will be explained in detail below.

After calculating the probability π_i, as defined in Eq. (1), an agent will renew the subscription if $\pi_i > \overline{\pi}$, where $\overline{\pi} \in (0, 1)$ is a random variable with uniform distribution within its support. Following a well-established approach to calibration (see, among others, Van der Vaart et al. 2016), the six variables of the model (age, health, sex, degree, expertise and the averaged combination of engagement with books, cinema and museum visits) have been weighted with all possible values for parameters α_j and β_j in the interval (0.05, 0.9), by steps of 0.05, maintaining that $\sum_{j=1}^{3}\alpha_j = \sum_{j=1}^{3}\beta_j = 1$. Over the 4210 possible combinations, obtained by means of an extensive Monte Carlo simulation of 1000 repetitions per each of them, 37 combinations of parameters were selected, providing, on average over the 1000 repetitions, a value of simulated renewals (r) in the range between 441.5 and 442.5, with standard deviations σ_r raging in the interval [13.45, 15.01]. Subsequently, these identified combinations have been used to assess the effect of several network configurations, thus describing the impact of social interaction on cultural consumption. Results are reported in Table 2a, where the first six columns ($\alpha_1, \alpha_2, \alpha_3, \beta_1, \beta_2, \beta_3$) report the 6-tuples of parameters being tested, the seventh one (r) reports the average value of renewals over 1000 repetitions, and the others $\left(r_{N_{inner}};\ \Delta r \rightarrow r_{N_{inner}};\ r_{N_{complete}};\ \Delta r \rightarrow r_{N_{complete}};\ \Delta r_{N_{inner}} \rightarrow r_{N_{complete}}\right)$ report the average values of renewals over 1,000 repetitions, referred to different network configurations and to the corresponding variations, as later described. Further, in Table 2b, the first six columns from the left ($\alpha_1, \alpha_2, \alpha_3, \beta_1, \beta_2, \beta_3$) show the same 6-tuples of parameters values as in Table 2a, whereas the other columns report the 95 percent confidence intervals for all average results, for each network configuration, as shown below (r; $95\%CIr$; $r_{inn}95\%CIr_{inn}$; $r_{com}95\%CIr_{com}$).

3.2 Centralization vs. Decentralization

Based on our calibration values, we simulate diverse engagement strategies. Our initial focus centers on examining the impact of orchestrating collaborative initiatives among the five leisure centers, as opposed to their conventional independent operations. The underlying conjecture posits that fostering heightened social interaction

Table 2 a Values for model parameters and network results, $r \in (441.5, 442.5)$; b 95% confidence intervals around average $r \in (441.5, 442.5)$

Table 2a

α_1	α_2	α_3	β_1	β_2	β_3	r	$r_{N_{inner}}$	$\Delta r \rightarrow r_{N_{inner}}$	$r_{N_{complete}}$	$\Delta r \rightarrow r_{N_{complete}}$	$\Delta r_{N_{inner}} \rightarrow r_{N_{complete}}$
0.15	0.80	0.05	0.05	0.20	0.75	441.72	536.98	21.57%	545.31	23.45%	1.55%
0.35	0.40	0.25	0.25	0.15	0.60	441.53	513.97	16.41%	521.54	18.12%	1.47%
0.25	0.55	0.20	0.15	0.15	0.70	442.41	522.91	18.20%	535.38	21.01%	2.38%
0.55	0.30	0.15	0.15	0.10	0.75	442.35	523.09	18.25%	529.12	19.62%	1.15%
0.20	0.65	0.15	0.20	0.20	0.60	441.52	519.75	17.72%	531.74	20.43%	2.31%
0.30	0.60	0.10	0.05	0.15	0.80	442.18	535.35	21.07%	539.93	22.11%	0.86%
0.25	0.45	0.30	0.25	0.15	0.60	442.36	518.83	17.29%	523.54	18.35%	0.91%
0.35	0.60	0.05	0.05	0.15	0.80	442.07	534.5	20.91%	548.47	24.07%	2.61%
0.50	0.20	0.30	0.30	0.10	0.60	442.09	511.3	15.65%	518.14	17.20%	1.34%
0.05	0.50	0.45	0.45	0.20	0.35	441.82	498.29	12.78%	510.11	15.46%	2.37%
0.35	0.55	0.10	0.10	0.15	0.75	441.85	528.83	19.69%	538.34	21.84%	1.80%
0.25	0.25	0.50	0.50	0.15	0.35	442.13	494.64	11.88%	500.48	13.20%	1.18%
0.05	0.75	0.20	0.15	0.20	0.65	442.02	530.3	19.97%	539.22	21.99%	1.68%
0.70	0.10	0.20	0.15	0.05	0.80	442.27	520.43	17.67%	526.52	19.05%	1.17%
0.65	0.30	0.05	0.10	0.10	0.80	442.39	529.3	19.65%	537.1	21.41%	1.47%
0.40	0.10	0.50	0.45	0.10	0.45	442.51	495.85	12.05%	504.93	14.10%	1.83%
0.15	0.60	0.25	0.30	0.20	0.50	442.23	518.47	17.24%	522.3	18.11%	0.74%
0.10	0.65	0.25	0.25	0.20	0.55	442.46	514.8	16.35%	530.9	19.99%	3.13%
0.45	0.25	0.30	0.25	0.10	0.65	442.00	514.37	16.37%	518.93	17.40%	0.89%
0.40	0.55	0.05	0.10	0.15	0.75	442.45	526.29	18.95%	537.44	21.47%	2.12%

Table 2 (continued)

Table 2a

α_1	α_2	α_3	β_1	β_2	β_3	r	$r_{N_{inner}}$	$\Delta r \rightarrow r_{N_{inner}}$	$r_{N_{complete}}$	$\Delta r \rightarrow r_{N_{complete}}$	$\Delta r_{N_{inner}} \rightarrow r_{N_{complete}}$
0.30	0.15	0.55	0.60	0.15	0.25	441.76	482.89	9.31%	491.11	11.17%	1.70%
0.20	0.10	0.70	0.70	0.15	0.15	442.47	474.1	7.15%	483.73	9.33%	2.03%
0.10	0.35	0.55	0.60	0.20	0.20	441.51	487.35	10.38%	493.44	11.76%	1.25%
0.10	0.70	0.20	0.20	0.20	0.60	442.04	526.04	19.00%	531.88	20.33%	1.11%
0.40	0.45	0.15	0.20	0.15	0.65	442.33	518.16	17.14%	530.35	19.90%	2.35%
0.55	0.25	0.20	0.20	0.10	0.70	441.56	518.17	17.35%	525.26	18.96%	1.37%
0.20	0.75	0.05	0.10	0.20	0.70	441.90	529.17	19.75%	538.19	21.79%	1.70%
0.15	0.50	0.35	0.40	0.20	0.40	441.67	502.85	13.85%	513.75	16.32%	2.17%
0.15	0.25	0.60	0.55	0.15	0.30	441.95	487.96	10.41%	499.57	13.04%	2.38%
0.30	0.30	0.40	0.40	0.15	0.45	441.72	500.49	13.30%	509.45	15.33%	1.79%
0.55	0.10	0.35	0.40	0.10	0.50	441.72	499.65	13.11%	507.37	14.86%	1.55%
0.20	0.05	0.75	0.75	0.15	0.10	441.62	471.31	6.72%	477.09	8.03%	1.23%
0.15	0.15	0.70	0.65	0.15	0.20	442.29	480.64	8.67%	487.95	10.32%	1.52%
0.10	0.45	0.45	0.50	0.20	0.30	442.33	494.47	11.79%	504.19	13.99%	1.97%
0.20	0.30	0.50	0.45	0.15	0.40	442.46	497.39	12.42%	506	14.36%	1.73%
0.35	0.50	0.15	0.15	0.15	0.70	441.64	520.92	17.95%	537.79	21.77%	3.24%
0.30	0.35	0.35	0.35	0.15	0.50	441.78	504.41	14.18%	514.69	16.50%	2.04%

Table 2b

α_1	α_2	α_3	β_1	β_2	β_3	r	$95\%CIr$	r_{inn}	$95\%CIr_{inn}$	r_{com}	$95\%CIr_{com}$
0.05	0.80	0.15	0.05	0.20	0.75	441.72 (13.45)	[440.81, 442.63]	536.98 (13.15)	[536.09, 537.87]	545.31 (12.55)	[544.46, 546.16]

Table 2 (continued)

Table 2b

α_1	α_2	α_3	β_1	β_2	β_3	r	$95\% CI r$	r_{inn}	$95\% CI r_{inn}$	r_{com}	$95\% CI r_{com}$
0.25	0.40	0.35	0.25	0.15	0.60	441.53 (13.64)	[440.6, 442.45]	513.97 (13.46)	[513.06, 514.88]	521.54 (13.6)	[520.62, 522.46]
0.20	0.55	0.25	0.15	0.15	0.70	442.41 (13.66)	[441.49, 443.34]	522.91 (13.65)	[521.99, 523.83]	535.38 (13.59)	[534.46, 536.3]
0.15	0.30	0.55	0.15	0.10	0.75	442.34 (13.71)	[441.42, 443.27]	523.09 (13.41)	[522.18, 524.0]	529.12 (13.32)	[528.22, 530.02]
0.15	0.65	0.20	0.20	0.20	0.60	441.52 (13.81)	[440.59, 442.46]	519.75 (13.78)	[518.82, 520.68]	531.74 (12.78)	[530.87, 532.61]
0.10	0.60	0.30	0.05	0.15	0.80	442.18 (13.84)	[441.24, 443.11]	535.35 (13.09)	[534.46, 536.24]	539.93 (13.0)	[539.05, 540.81]
0.30	0.45	0.25	0.25	0.15	0.60	442.36 (13.89)	[441.41, 443.3]	518.83 (13.36)	[517.92, 519.74]	523.54 (13.28)	[522.64, 524.44]
0.05	0.60	0.35	0.05	0.15	0.80	442.07 (13.91)	[441.13, 443.01]	534.5 (13.27)	[533.6, 535.4]	548.47 (12.92)	[547.59, 549.35]
0.30	0.20	0.50	0.30	0.10	0.60	442.09 (13.93)	[441.15, 443.04]	511.3 (14.19)	[510.34, 512.26]	518.14 (13.62)	[517.22, 519.06]
0.45	0.50	0.05	0.45	0.20	0.35	441.82 (13.93)	[440.88, 442.76]	498.29 (14.3)	[497.32, 499.26]	510.11 (13.29)	[509.21, 511.01]
0.10	0.55	0.35	0.10	0.15	0.75	441.84 (13.93)	[440.9, 442.79]	528.83 (12.54)	[527.98, 529.68]	538.34 (13.63)	[537.42, 539.26]
0.50	0.25	0.25	0.50	0.15	0.35	442.13 (13.96)	[441.19, 443.08]	494.64 (13.83)	[493.7, 495.58]	500.48 (13.86)	[499.54, 501.42]
0.20	0.75	0.05	0.15	0.20	0.65	442.02 (14.02)	[441.07, 442.96]	530.30 (13.21)	[529.41, 531.19]	539.22 (12.39)	[538.38, 540.06]
0.20	0.10	0.70	0.15	0.05	0.80	442.27 (14.03)	[441.32, 443.22]	520.43 (13.47)	[519.52, 521.34]	526.52 (13.37)	[525.61, 527.43]
0.05	0.30	0.65	0.10	0.10	0.80	442.38 (14.04)	[441.43, 443.34]	529.30 (13.48)	[528.39, 530.21]	537.1 (13.35)	[536.2, 538.0]
0.50	0.10	0.40	0.45	0.10	0.45	442.51 (14.08)	[441.56, 443.47]	495.85 (14.32)	[494.88, 496.82]	504.93 (13.78)	[504.0, 505.86]
0.25	0.60	0.15	0.30	0.20	0.50	442.23 (14.11)	[441.27, 443.18]	518.47 (13.08)	[517.58, 519.36]	522.3 (13.41)	[521.39, 523.21]
0.25	0.65	0.10	0.25	0.20	0.55	442.46 (14.13)	[441.5, 443.41]	514.8 (13.58)	[513.88, 515.72]	530.9 (13.61)	[529.98, 531.82]
0.30	0.25	0.45	0.25	0.10	0.65	442.00 (14.16)	[441.04, 442.96]	514.37 (13.79)	[513.44, 515.3]	518.93 (13.62)	[518.01, 519.85]
0.05	0.55	0.40	0.10	0.15	0.75	442.45 (14.16)	[441.49, 443.41]	526.29 (13.19)	[525.4, 527.18]	537.44 (12.94)	[536.56, 538.32]
0.55	0.15	0.30	0.60	0.15	0.25	441.76 (14.17)	[440.8, 442.72]	482.89 (13.9)	[481.95, 483.83]	491.11 (14.04)	[490.16, 492.06]
0.70	0.10	0.20	0.70	0.15	0.15	442.47 (14.18)	[441.51, 443.43]	474.10 (14.07)	[473.15, 475.05]	483.73 (14.09)	[482.78, 484.68]

Table 2 (continued)

Table 2b

α_1	α_2	α_3	β_1	β_2	β_3	r	$95\%CIr$	r_{inn}	$95\%CIr_{inn}$	r_{com}	$95\%CIr_{com}$
0.55	0.35	0.10	0.60	0.20	0.20	441.51 (14.19)	[440.55, 442.47]	487.35 (13.6)	[486.43, 488.27]	493.44 (14.24)	[492.48, 494.4]
0.20	0.70	0.10	0.20	0.20	0.60	442.04 (14.25)	[441.07, 443.0]	526.04 (13.26)	[525.14, 526.94]	531.88 (13.03)	[531.0, 532.76]
0.15	0.45	0.40	0.20	0.15	0.65	442.33 (14.25)	[441.37, 443.3]	518.16 (13.64)	[517.24, 519.08]	530.35 (13.4)	[529.44, 531.26]
0.20	0.25	0.55	0.20	0.10	0.70	441.56 (14.25)	[440.59, 442.52]	518.17 (13.05)	[517.29, 519.05]	525.26 (13.41)	[524.35, 526.17]
0.05	0.75	0.20	0.10	0.20	0.70	441.9 (14.3)	[440.93, 442.87]	529.17 (13.09)	[528.28, 530.06]	538.19 (13.38)	[537.28, 539.1]
0.35	0.50	0.15	0.40	0.20	0.40	441.67 (14.33)	[440.7, 442.64]	502.85 (14.19)	[501.89, 503.81]	513.75 (13.85)	[512.81, 514.69]
0.60	0.25	0.15	0.55	0.15	0.30	441.94 (14.36)	[440.97, 442.92]	487.96 (13.94)	[487.02, 488.9]	499.57 (14.34)	[498.6, 500.54]
0.40	0.30	0.30	0.40	0.15	0.45	441.72 (14.45)	[440.74, 442.7]	500.49 (13.54)	[499.57, 501.41]	509.45 (12.89)	[508.58, 510.32]
0.35	0.10	0.55	0.40	0.10	0.50	441.72 (14.46)	[440.74, 442.7]	499.65 (13.7)	[498.72, 500.58]	507.37 (13.97)	[506.42, 508.32]
0.75	0.05	0.20	0.75	0.15	0.10	441.62 (14.48)	[440.64, 442.6]	471.31 (14.81)	[470.31, 472.31]	477.09 (14.72)	[476.09, 478.09]
0.70	0.15	0.15	0.65	0.15	0.20	442.29 (14.49)	[441.31, 443.28]	480.64 (14.25)	[479.67, 481.61]	487.95 (13.46)	[487.04, 488.86]
0.45	0.45	0.10	0.50	0.20	0.30	442.33 (14.57)	[441.34, 443.31]	494.47 (13.67)	[493.54, 495.4]	504.19 (13.47)	[503.28, 505.1]
0.50	0.30	0.20	0.45	0.15	0.40	442.46 (14.69)	[441.46, 443.45]	497.39 (13.77)	[496.46, 498.32]	506.0 (13.7)	[505.07, 506.93]
0.15	0.50	0.35	0.15	0.15	0.70	441.64 (14.85)	[440.64, 442.65]	520.92 (13.56)	[520.0, 521.84]	537.79 (13.15)	[536.9, 538.68]
0.35	0.35	0.30	0.35	0.15	0.50	441.78 (15.01)	[440.76, 442.79]	504.41 (14.07)	[503.46, 505.36]	514.69 (13.61)	[513.77, 515.61]

Standard deviations in parentheses

among participants could potentially encourage renewal subscriptions. This hypothesis is underpinned by the notion of a favorable contagion effect, as elucidated by Bahramnezhad et al. (2017) and Schmidt et al. (2021), wherein an amplification in interpersonal engagement gives rise to a commensurate escalation in the number of subscription renewals.

In the model, the interaction among agents occurs according to two distinct network scenarios: inner and complete. The first refers to the case in which interactions occur among individuals affiliated with one of the five leisure centers only. Let P be the set of agents. Each of the five probabilistic networks, G_k, enrolls a subset of agents k, such that $P_k \subset P$. The set of links, L_k, consists of all connections established among the P_k agents, thus ignoring individuals enrolled in other centres. By contrast, the second scenario arises when interactions occur between agents hailing from different leisure centers, thus fostering a more expansive web of human connections. In this case, we define a unique probabilistic network, G, including all P agents, without partitioning them into subsets.

The ability of agents to cultivate social connections hinges upon their inclination towards interpersonal engagement, gauged through their involvement in courses, clubs, volunteering endeavors, and joint museum visits. Precisely, we employ Likert scale questionnaires to allocate scores to each of these variables, denoted as $\theta_{(I,i)}$, $\theta_{(II,i)}$, $\theta_{(III,i)}$, and $\theta_{(IV,i)}$, respectively. The likelihood of an agent forming a social connection is computed as follows:

$$\nu_i = \frac{1}{4}\left(\theta_{I,i}+\theta_{II,i} + \theta_{III,i}+\theta_{IV,i}\right) \tag{4}$$

where $\theta_{(h,i)} \in [0,1]$, $h = I, II, III, IV$, thus being $\nu_i \in [0,1]$. Consequently, if the network is constrained to local leisure centers (inner network) only, an agent i will establish an interaction with another agent j if$\left(\nu_i + \nu_j\right) > \xi$; conversely, if the network encompasses the entire community (complete network), a connection between agents i and j is formed if $\left(\nu_i + \nu_j\right) > \xi \wedge \delta > d_{k_a,k_b}$. Both $\xi \in [0, 2]$ and $\delta \in [0, 1]$ are random variables with uniform distribution within their supports, while d_{k_a,k_b} is the relative physical distance between centres a and b, where agent i and agent$j$ are enrolled, computed as$D_{k_a,k_b}/D$, being D_{k_a,k_b} the absolute physical distance and $D = sup\left\{D_{k_a,k_b} : a, b \in 1, 2, 3, 4, 5\right\}$.

As shown in Table 2a, for all 37 parameters settings, averaged results over 1000 repetitions show that the presence of social networks increases the number of renewals. In particular, the average value of renewals obtained by considering the inner social network (column $r_{N_{inner}}$) is always greater than the corresponding value obtained without networks (column r), with percent increments ranging in the interval [6.72, 21.57] (reported in column $\Delta r \rightarrow r_{N_{inner}}$). Moving to the complete network setting, the percent increment in the simulated renewals (in column $r_{N_{complete}}$) is sizable, ranging in the interval [10.32, 24.07] (as shown by values in column $\Delta r \rightarrow r_{N_{complete}}$). Passing from the inner to the complete network always induces a net increment in the average number of renewals (as shown by values in column $\Delta r_{N_{inner}} \rightarrow r_{N_{complete}}$).

Taking our analysis a step further, we studied potential disparities by targeting distinct age groups, as opposed to general interventions. To reveal the relative weight of age classes in affecting the total amount of renewals can be useful to tune properly the policy action. All simulation results have been rescaled to ensure an equivalent number of agents as in the original sample. For each of 37 identified parameters combinations, 1000 Monte Carlo simulations have been performed by removing from the community all individuals belonging to a specific age class (class 1 corresponds to participants aged 60 to 64, class 2 to those aged 65 to 69, class 3 to those aged 70 to 74, class 4 to those aged 75 to 79, class 5 to those aged 80 to 84, and class 6 to individuals older than 84). Table 3a–c present average renewals over 1000 Monte Carlo simulations referred, respectively, to cases without single age classes (Table 3a and b) and to cases with individuals younger than 75 and older than 74 only (Table 3c). First, also in cases without specific age classes, simulations confirm that networks always increase the number of renewals. This suggest that the effect played by connections prevails on the reduction implied by reducing each age class. Secondly, age classes have a different impact on renewals, which aligns with expectations, as the removal of older individuals leads to a relative increase in the number of renewals, as expectedly due to potential health limitations associated with age. Indeed, the impact of each of last three age classes is smaller than that of one of the first three age classes. This evidence can be read also in lines of Table 3c, where the reduction of renewals obtained by eliminating the first three classes is greater than the increase induced by the elimination of the last three ones.

3.3 Cultural Leaders and Influencers

In the preceding subsection, we assumed that agents have equal influence in the network. We now focus on a scenario wherein certain agents wield more significance than others. This may happen either when one agent has a cultural leadership due to higher values than others in his cultural variables (namely, e_i, m_i, b_i, c_i), or when an agent has many personal contacts, thus being a pivotal “hub” or central node within the network (Sargent and Stachurski 2022), irrespective of cultural attributes. We adopt the terms “leader” and “influencer” to describe, respectively, these two cases.

To define a leader, each agent$i$ compares his own cultural variables with those of other agents in his network P_i. Should agent i discover that any of his peers, say agent j, exhibits the highest values among agents belonging to P_i for any of the four attributes, then agent i can learn from agent j and agent j becomes a leader. This adjustment mimics a probabilistic learning, in which each agent can improve his attributes by assuming the same values of his best peer. We have endowed agents with a threshold, $\mu_i \sim (0.25, 0.0625)$, defined as a random variable with uniform distribution within its support, measuring the ‘personal resistance’ to learn, as a behavioral reluctance. Specifically, an agent i accepts to learn from someone else if $\mu_i < \nu_i$ and the learning consists in redefining the cultural variable of agent i as:

$$x_i = x_i + rnd(sup\left\{x_j \geq x_i \in P_i\right\} - x_i) \quad (5)$$

being $x_i = e_i, m_i, b_i, c_i$. Therefore, interpersonal interactions wield a constructive “contagion effect”, influencing the cultural facet of the renewal probability.

Table 3 a Normalized renewals without selected age classes (1 to 3); b normalized renewals without selected age classes (4 to 6); c normalized renewals with youngest ($r_{\cdot}^{4-6}$) and oldest ($r_{\cdot}^{1-3}$) age classes

Table 3a

α_1	α_2	α_3	β_1	β_2	β_3	r_{nonet}^1	r_{inn}^1	r_{com}^1	r_{nonet}^2	r_{inn}^2	r_{com}^2	r_{nonet}^3	r_{inn}^3	r_{com}^3
0.05	0.8	0.15	0.05	0.2	0.75	428.67	472.56	487.23	433.24	476.43	492.74	447.66	492.16	504.15
0.25	0.4	0.35	0.25	0.15	0.6	423.47	457.72	468.67	429.55	462.54	472.76	445.91	482.26	491.19
0.2	0.55	0.25	0.15	0.15	0.7	428.44	467.61	476.96	433.46	471.42	479.06	449.78	485.81	497.83
0.15	0.3	0.55	0.15	0.1	0.75	419.24	457.09	469.24	427.68	461.36	471.88	449.44	485.42	495.61
0.15	0.65	0.2	0.2	0.2	0.6	427.63	465.99	476.47	432.39	469.20	481.75	447.78	483.77	497.06
0.1	0.6	0.3	0.05	0.15	0.8	425.27	467.56	480.65	430.72	472.53	485.98	447.61	490.13	501.21
0.3	0.45	0.25	0.25	0.15	0.6	427.73	463.87	472.43	433.41	465.78	475.89	447.00	477.87	494.22
0.05	0.6	0.35	0.05	0.15	0.8	424.91	470.58	483.69	430.52	470.82	481.90	448.03	493.05	506.29
0.3	0.2	0.5	0.3	0.1	0.6	422.15	451.53	465.22	430.61	459.40	469.29	450.28	480.87	489.79
0.45	0.5	0.05	0.45	0.2	0.35	433.04	463.35	474.59	436.41	461.84	471.08	446.89	476.53	483.22
0.1	0.55	0.35	0.1	0.15	0.75	424.23	468.33	476.67	430.73	467.40	484.18	448.65	485.50	501.23
0.5	0.25	0.25	0.5	0.15	0.35	428.56	454.12	461.43	433.46	456.74	466.65	447.59	472.21	479.51
0.2	0.75	0.05	0.15	0.2	0.65	433.15	470.96	489.30	435.07	474.41	488.18	446.93	484.98	494.00
0.2	0.1	0.7	0.15	0.05	0.8	416.34	451.88	463.60	426.14	461.43	467.93	448.17	483.39	493.20
0.05	0.3	0.65	0.1	0.1	0.8	416.21	455.68	465.51	425.11	464.57	473.12	449.21	484.00	500.37
0.5	0.1	0.4	0.45	0.1	0.45	424.72	450.16	457.08	431.77	456.38	463.69	448.61	472.36	478.41
0.25	0.6	0.15	0.3	0.2	0.5	429.76	464.84	473.00	434.73	469.34	476.26	447.13	481.29	493.24
0.25	0.65	0.1	0.25	0.2	0.55	431.72	467.88	481.63	434.21	469.41	480.21	446.75	482.64	492.25
0.3	0.25	0.45	0.25	0.1	0.65	422.54	456.10	463.45	430.22	464.25	473.62	448.76	483.88	490.10

Table 3 (continued)

Table 3a

α_1	α_2	α_3	β_1	β_2	β_3	r^1_{nonet}	r^1_{inn}	r^1_{com}	r^2_{nonet}	r^2_{inn}	r^2_{com}	r^3_{nonet}	r^3_{inn}	r^3_{com}
0.05	0.55	0.4	0.1	0.15	0.75	424.11	464.28	479.44	430.40	467.89	482.78	450.40	493.14	501.02
0.55	0.15	0.3	0.6	0.15	0.25	427.44	447.89	456.22	433.23	451.72	461.38	447.81	467.78	474.74
0.7	0.1	0.2	0.7	0.15	0.15	429.97	447.73	453.23	435.81	451.84	457.36	447.57	463.33	469.71
0.55	0.35	0.1	0.6	0.2	0.2	430.83	453.20	462.88	435.39	455.28	464.20	445.98	468.03	475.43
0.2	0.7	0.1	0.2	0.2	0.6	431.58	469.21	482.43	435.72	471.93	482.81	448.06	486.43	497.24
0.15	0.45	0.4	0.2	0.15	0.65	423.69	459.51	471.45	430.01	464.02	476.50	448.78	482.19	498.24
0.2	0.25	0.55	0.2	0.1	0.7	418.42	451.70	469.63	428.50	460.01	473.96	448.40	481.12	493.10
0.05	0.75	0.2	0.1	0.2	0.7	428.27	471.14	485.71	431.71	470.87	485.65	448.49	490.43	498.68
0.35	0.5	0.15	0.4	0.2	0.4	430.18	457.71	470.36	433.13	463.03	473.50	446.70	478.19	482.52
0.6	0.25	0.15	0.55	0.15	0.3	431.55	454.60	462.60	436.18	457.96	466.53	447.63	470.52	474.45
0.4	0.3	0.3	0.4	0.15	0.45	426.64	452.60	463.45	432.11	459.50	468.62	446.87	476.46	483.08
0.35	0.1	0.55	0.4	0.1	0.5	421.55	447.66	455.94	429.35	456.01	465.52	450.10	476.54	486.62
0.75	0.05	0.2	0.75	0.15	0.1	429.11	444.09	452.24	435.74	448.49	454.19	447.83	461.40	468.20
0.7	0.15	0.15	0.65	0.15	0.2	432.56	449.95	457.08	435.39	453.72	457.28	446.63	466.27	470.38
0.45	0.45	0.1	0.5	0.2	0.3	432.52	458.35	466.61	436.01	461.36	469.26	447.55	475.32	482.56
0.5	0.3	0.2	0.45	0.15	0.4	429.29	456.20	464.70	433.63	458.60	468.83	447.65	474.58	479.01
0.15	0.5	0.35	0.15	0.15	0.7	424.86	461.39	477.06	431.90	468.73	477.60	447.23	484.73	496.21
0.35	0.35	0.3	0.35	0.15	0.5	426.23	456.07	467.60	431.30	462.51	469.88	447.82	480.36	486.95

Table 3 (continued)

Table 3b

α_1	α_2	α_3	β_1	β_2	β_3	r^4_{nonet}	r^4_{inn}	r^4_{com}	r^5_{nonet}	r^5_{inn}	r^5_{com}	r^6_{nonet}	r^6_{inn}	r^6_{com}
0.05	0.80	0.15	0.05	0.20	0.75	449.36	493.11	510.51	447.26	491.81	503.73	442.93	486.85	498.06
0.25	0.40	0.35	0.25	0.15	0.60	451.28	485.56	496.91	447.12	479.97	492.97	441.66	476.82	487.47
0.20	0.55	0.25	0.15	0.15	0.70	452.15	489.37	501.84	448.61	486.26	496.84	443.25	481.30	492.07
0.15	0.30	0.55	0.15	0.10	0.75	457.74	493.26	503.60	450.64	486.15	501.46	444.40	480.81	492.55
0.15	0.65	0.20	0.20	0.20	0.60	449.15	485.00	496.64	446.37	483.23	493.39	442.36	481.28	493.64
0.10	0.60	0.30	0.05	0.15	0.80	451.92	496.24	503.21	448.04	491.12	503.04	443.81	486.49	499.76
0.30	0.45	0.25	0.25	0.15	0.60	449.94	485.94	497.44	446.82	482.32	491.47	442.52	477.49	489.11
0.05	0.60	0.35	0.05	0.15	0.80	453.81	499.52	506.23	448.87	494.10	504.60	444.62	483.17	501.36
0.30	0.20	0.50	0.30	0.10	0.60	456.31	487.64	497.14	451.27	481.68	490.55	445.50	475.67	484.65
0.45	0.50	0.05	0.45	0.20	0.35	446.55	474.26	484.71	444.91	474.34	481.44	442.21	470.23	479.29
0.10	0.55	0.35	0.10	0.15	0.75	452.49	491.80	506.97	449.47	487.15	502.89	443.86	483.61	494.12
0.50	0.25	0.25	0.50	0.15	0.35	450.93	474.46	481.78	446.96	471.15	477.66	443.22	469.00	475.38
0.20	0.75	0.05	0.15	0.20	0.65	447.34	485.21	502.72	444.89	482.85	496.00	442.88	481.78	497.65
0.20	0.10	0.70	0.15	0.05	0.80	459.21	493.77	504.72	452.43	487.86	497.74	444.54	480.48	489.65
0.05	0.30	0.65	0.10	0.10	0.80	458.03	496.08	509.06	453.01	491.12	499.81	444.06	482.08	491.79
0.50	0.10	0.40	0.45	0.10	0.45	452.52	477.03	482.74	448.67	473.28	479.58	444.24	467.88	477.44
0.25	0.60	0.15	0.30	0.20	0.50	449.89	483.38	496.06	446.65	481.33	490.38	443.41	477.44	487.97
0.25	0.65	0.10	0.25	0.20	0.55	448.17	483.87	492.85	446.57	483.38	492.92	443.00	479.76	489.89
0.30	0.25	0.45	0.25	0.10	0.65	454.22	484.88	497.74	449.86	481.61	492.49	444.14	479.37	485.93

Table 3 (continued)

Table 3b

α_1	α_2	α_3	β_1	β_2	β_3	r^4_{nonet}	r^4_{inn}	r^4_{com}	r^5_{nonet}	r^5_{inn}	r^5_{com}	r^6_{nonet}	r^6_{inn}	r^6_{com}
0.05	0.55	0.40	0.10	0.15	0.75	456.05	495.41	508.57	450.86	491.62	502.87	445.17	484.91	495.38
0.55	0.15	0.30	0.60	0.15	0.25	451.46	470.10	478.61	447.38	468.43	473.67	443.21	465.73	472.78
0.70	0.10	0.20	0.70	0.15	0.15	449.30	465.18	469.73	446.17	462.46	469.12	443.02	459.41	465.45
0.55	0.35	0.10	0.60	0.20	0.20	447.21	467.64	474.02	444.78	466.85	472.90	442.73	461.89	471.55
0.20	0.70	0.10	0.20	0.20	0.60	448.75	490.18	501.33	446.60	485.34	497.61	442.99	480.54	492.68
0.15	0.45	0.40	0.20	0.15	0.65	453.69	491.20	500.94	449.81	486.50	496.97	444.49	478.68	490.41
0.20	0.25	0.55	0.20	0.10	0.70	455.76	489.87	502.86	451.09	485.56	493.90	444.07	478.10	487.39
0.05	0.75	0.20	0.10	0.20	0.70	451.58	494.62	504.45	448.03	488.82	501.57	443.79	482.76	496.59
0.35	0.50	0.15	0.40	0.20	0.40	449.05	479.41	487.41	445.10	475.56	483.49	441.91	470.11	483.33
0.60	0.25	0.15	0.55	0.15	0.30	448.58	470.61	479.75	445.82	468.46	476.86	443.88	466.88	473.24
0.40	0.30	0.30	0.40	0.15	0.45	450.20	479.64	485.51	447.11	475.02	486.99	443.25	469.95	480.17
0.35	0.10	0.55	0.40	0.10	0.50	456.64	483.73	490.47	451.85	477.50	486.04	445.17	471.47	478.26
0.75	0.05	0.20	0.75	0.15	0.10	447.27	461.62	468.67	445.08	460.54	463.58	443.26	455.76	462.67
0.70	0.15	0.15	0.65	0.15	0.20	448.17	466.25	472.87	445.63	462.85	470.64	442.64	460.46	466.52
0.45	0.45	0.10	0.50	0.20	0.30	448.74	474.44	479.23	445.91	471.37	482.25	442.33	468.87	477.28
0.50	0.30	0.20	0.45	0.15	0.40	448.99	474.58	485.56	445.84	472.67	480.45	442.48	469.12	477.59
0.15	0.50	0.35	0.15	0.15	0.70	453.48	492.37	501.03	448.40	485.22	499.06	443.62	482.97	491.79
0.35	0.35	0.30	0.35	0.15	0.50	451.50	481.54	493.64	447.46	474.81	487.37	443.30	472.70	484.49

Table 3 (continued)

Table 3c

α_1	α_2	α_3	β_1	β_2	β_3	r_{nonet}^{1-3}	r_{inn}^{1-3}	r_{com}^{1-3}	r_{nonet}^{4-6}	r_{inn}^{4-6}	r_{com}^{4-6}
0.05	0.80	0.15	0.05	0.20	0.75	399.83	437.53	462.85	459.27	500.52	514.50
0.25	0.40	0.35	0.25	0.15	0.60	382.66	417.66	423.63	463.61	496.02	510.51
0.20	0.55	0.25	0.15	0.15	0.70	392.72	429.51	438.51	461.68	500.70	511.86
0.15	0.30	0.55	0.15	0.10	0.75	362.55	400.99	408.51	473.64	511.13	522.89
0.15	0.65	0.20	0.20	0.20	0.60	395.89	433.80	442.80	459.36	495.28	507.20
0.10	0.60	0.30	0.05	0.15	0.80	385.79	426.66	443.26	463.55	507.16	514.55
0.30	0.45	0.25	0.25	0.15	0.60	394.41	424.76	441.36	461.09	496.61	503.33
0.05	0.60	0.35	0.05	0.15	0.80	380.10	420.50	430.84	467.20	509.12	522.06
0.30	0.20	0.50	0.30	0.10	0.60	373.17	404.15	416.60	471.50	500.62	508.11
0.45	0.50	0.05	0.45	0.20	0.35	417.44	444.81	449.27	452.50	478.74	490.06
0.10	0.55	0.35	0.10	0.15	0.75	381.05	423.70	439.00	466.13	507.48	519.74
0.50	0.25	0.25	0.50	0.15	0.35	397.65	422.19	430.11	459.99	484.24	493.68
0.20	0.75	0.05	0.15	0.20	0.65	411.54	451.80	458.80	453.45	492.40	507.26
0.20	0.10	0.70	0.15	0.05	0.80	348.83	384.88	391.70	478.36	513.94	524.49
0.05	0.30	0.65	0.10	0.10	0.80	351.96	391.35	403.41	476.67	516.08	526.74
0.50	0.10	0.40	0.45	0.10	0.45	383.30	409.71	416.99	466.50	490.39	495.90
0.25	0.60	0.15	0.30	0.20	0.50	404.01	439.46	449.55	457.56	490.18	499.80
0.25	0.65	0.10	0.25	0.20	0.55	406.68	446.14	452.33	454.41	488.65	502.83
0.30	0.25	0.45	0.25	0.10	0.65	374.86	407.39	419.87	469.04	502.88	508.61

Table 3 (continued)

Table 3c

α_1	α_2	α_3	β_1	β_2	β_3	r_{nonet}^{1-3}	r_{inn}^{1-3}	r_{com}^{1-3}	r_{nonet}^{4-6}	r_{inn}^{4-6}	r_{com}^{4-6}
0.05	0.55	0.40	0.10	0.15	0.75	376.26	417.27	430.91	469.84	508.32	520.13
0.55	0.15	0.30	0.60	0.15	0.25	395.11	412.77	419.70	461.41	481.66	488.23
0.70	0.10	0.20	0.70	0.15	0.15	405.70	423.39	432.18	456.74	471.10	480.25
0.55	0.35	0.10	0.60	0.20	0.20	411.68	435.28	440.83	452.15	474.06	482.04
0.20	0.70	0.10	0.20	0.20	0.60	407.00	444.24	455.88	457.56	495.70	505.61
0.15	0.45	0.40	0.20	0.15	0.65	376.09	413.12	420.12	467.60	503.51	513.97
0.20	0.25	0.55	0.20	0.10	0.70	363.11	399.58	409.64	472.87	507.44	517.93
0.05	0.75	0.20	0.10	0.20	0.70	395.18	429.96	454.23	460.77	504.94	518.60
0.35	0.50	0.15	0.40	0.20	0.40	404.22	432.39	442.38	455.28	484.58	498.54
0.60	0.25	0.15	0.55	0.15	0.30	411.19	430.07	441.78	455.82	479.51	486.00
0.40	0.30	0.30	0.40	0.15	0.45	389.38	417.16	428.17	460.69	490.92	495.55
0.35	0.10	0.55	0.40	0.10	0.50	366.70	393.07	400.42	472.58	500.68	508.18
0.75	0.05	0.20	0.75	0.15	0.10	405.77	420.72	429.26	454.84	470.19	475.50
0.70	0.15	0.15	0.65	0.15	0.20	411.96	430.04	435.28	454.41	471.89	477.93
0.45	0.45	0.10	0.50	0.20	0.30	410.90	435.80	448.11	454.51	479.10	489.74
0.50	0.30	0.20	0.45	0.15	0.40	402.01	428.77	437.95	457.71	485.98	491.85
0.15	0.50	0.35	0.15	0.15	0.70	381.96	421.24	431.72	465.83	501.79	514.80
0.35	0.35	0.30	0.35	0.15	0.50	390.19	417.48	432.22	462.04	492.29	500.93

To identify influencers, we employ a centrality measure referred to as eigenvector centrality. For each person i, this measure is defined as a weighted average of the centrality of the person's neighbours:

$$\gamma_i = \frac{1}{\eta} \sum_{j=1}^{N} A_{i,j} \gamma_j \tag{6}$$

where η is the highest eigenvalue of the adjacency matrix A of the given social network, and N is the cardinality of the set of nodes, i.e., the number of agents.

Our hypothesis involves directing policies exclusively toward individuals possessing γ_i values greater than or equal to a given threshold, denoted as $\overline{\gamma}$. These agents stand as the most pivotal within the network, and policies can strategically amplify their contributions through targeted incentives. For instance, offering bonuses or complimentary renewals in return for their proactive involvement and enhanced experiences. Consequently, their centrality assumes a distinct advantage in reaching out to the broader communit—yan endeavor that would prove significantly costlier for policymakers to undertake directly.

In essence, we are questioning the notion of prioritizing network centrality as a principal driver for cultural policies, surpassing the intrinsic level of cultural competence. Our results show that a direct involvement of influencers in the strategy of cultural policies is convenient.

This conclusion comes from 1000 simulations across two scenarios, accounting for leaders (as defined in Eq. 5) and alternatively, for influencers (as defined in Eq. 6). In the case of leaders, there were 377 leaders in the 'inner' scenario and 271 in the 'complete' scenario potentially influencing the actions of 460 and 566 individuals, respectively. In the case of influencers, we opt for agents with $\gamma_i \geq 0.7$. This choice is motivated by the notion of selecting a threshold significantly above the mean centrality to guarantee the identification of the most influential agents. In the "inner" network, we identify 152 influencers with the potential to engage with 674 individuals, while in the "complete" network, the number of influencers decreases to 95, potentially connecting with 733 agents. While not all potential contacts will necessarily translate into renewals, the data indicates that holding a central role within the network is advantageous for influencers in terms of potential connections. This approach reduces the costs and time needed for policy implementation. Table 4 presents the outcomes for the two scenarios.

4 Final Remarks

Engaging the elderly demographic should be a central focus of cultural activity involvement strategies. Substantial literature underscores the significant positive impact of such policies on the well-being of older individuals. The project 'Il quartiere al Museo', containing the data used in this paper, is an example of these initiatives. The project entailed the provision of complimentary museum passes to elderly individuals who frequented public leisure centers in Turin. Additionally, it encompassed a structured

Table 4 Leaders vs. influencers

Network	Leaders	Reached
Inner	377	460
Complete	271	566
Network	**Influencers**	**Reached**
Inner	152	674
Complete	95	733

itinerary of visits to the local museum. At the conclusion of the one-year trial, participants were offered the opportunity to enroll in a paid subscription for the subsequent year.

The core challenge of this paper lied in extrapolating the outcomes of this project to discern prospective guidelines for forthcoming engagement endeavors. To explore this perspective, this paper presented an agent-based model, designed to replicate the observed effective renewal rates among the participants to the initiative. We extensively tested all parameters settings replicating sample values and, after calibrating the model, we performed policy simulations aimed at assessing the efficacy of various strategies fostering cultural engagement among the elderly.

Specifically, we studied two distinct aspects of cultural policy. The first one is represented by the comparison between decentralized and centralized policy approaches, here represented by the inner and completed networks, respectively. The second analyzes the difference between cultural leadership and social influence in reaching people. In both of them, the overarching theme was to amplify interactions to influence the outcomes of engagement policies. Regarding the problem of policy centralization, our results show that the adoption of social networks always increases renewals and that, in particular, a complete network gave evidence of a higher number of renewals than an inner network, characterized by isolated centers. Shifting the focus to the influencers, the results pointed out a particularly promising strategy: to rely on influencers should become the primary drivers of engagement policies rather than leaving these policies to spontaneous grouping guided by competence and cultural knowledge (represented in the model by the action of leaders). The connection with a relevant number of agents augments the potential for increased renewals.

The paper contributes to the cultural consumption literature in several relevant dimensions. Primarily, this study illuminates a demographic dynamic that has been relatively overlooked yet it is rapidly expanding—the elderly population facing substantial barriers to cultural consumption. Drawing insights from an actual engagement initiative directed towards older individuals, we present guidelines that could facilitate the implementation of effective policies. Moreover, within the context of this study, we harness the potential of an agent-based model—a methodology that has seen relatively limited application within this specific research domain. The strength of this approach lies in its capability to model interactions between agents, a fundamental dimension that plays a pivotal role in shaping any effective engagement strategy. The choice of an agent-based model provides the possibility to replicate the community of respondents and make some policy hypotheses in simulated scenarios where actual personal features of people can be implemented. By delving into the dynamics of how individuals interact and influence one another within a simulated environment, the agent-based model provides a richer understanding of the underlying mechanisms that drive cultural engagement outcomes among older adults. This marks a significant contribution to the field, offering a fresh perspective with the potential to shape more tailored and impactful policies in the future.

Acknowledgements The data utilized in this paper were gathered as part of the project titled 'Il quartiere al Museo', funded by Fondazione Compagnia di San Paolo in collaboration with Associazione Abbonamento Musei and the Case del Quartiere of Turin. The authors thank Sandra Aloia and Simona Ricci for authorizing the use of data and Eleonora Serra, Andrea Azeglio, Pasquale Iacobone, and Roberto Mautino for their help in collecting data.

Funding Open access funding provided by Università degli Studi di Catania within the CRUI-CARE Agreement.

Declarations

Conflict of interest All authors declare no conflict of interest.

Appendix

See Tables 5 and 6 here.

Table 5 displays results of four different specifications of a reduced-form model elucidating the decision to renew the Museum Card upon program completion. The first specification includes only demographic variables and health status; the second adds education, competences in the art domain, and participation in cultural activities; the third further includes proxies for the intensity of social life and involvement in voluntary activities. Finally, the fourth specification includes proxies for the networking activity characterizing the leisure centers that the individual frequents and the relative incidence of art experts among attendants. Following Angrist and Pischke (2009), we apply the OLS estimation technique even if the dependent variable is binary. The results generally confirm the expected sign of the effect of different variables on the decision to renew the card. Results show that renewals are positively and significantly correlated with the level of cultural consumption of individuals and the number of visits to the museums along the project. Additionally, renewal also critically depends on the characteristics of the other attendants of the leisure center, namely the relative

Table 5 Econometric estimates of the renewals

	(1)	(2)	(3)	(4)
Man	– 0.026	– 0.028	– 0.049	– 0.003
	(0.025)	(0.026)	(0.026)	(0.018)
Age	– 0.046	– 0.039	– 0.023	– 0.032
	(0.029)	(0.029)	(0.027)	(0.015)
Good health	0.034	0.035	0.010	– 0.009
	(0.036)	(0.037)	(0.048)	(0.029)
High School diploma		0.025	0.052*	0.052
		(0.021)	(0.024)	(0.028)
Art connoisseur°		– 0.099	– 0.034	– 0.061
		(0.208)	(0.200)	(0.159)
Museums visitor		– 0.018	– 0.017	– 0.034
		(0.038)	(0.027)	(0.028)
Movie spectator		0.112***	0.153***	0.114***
		(0.015)	(0.013)	(0.018)
Book reader		0.049	0.022	0.019
		(0.039)	(0.045)	(0.044)
Volunteer			0.033	0.032
			(0.027)	(0.027)
Club member			0.058	0.027
			(0.044)	(0.030)
N visits			0.036**	0.109***
			(0.009)	(0.010)
% of art connoisseurs°”				20.153***
				(2.963)
% of volunteers”				7.775***
				(0.960)
% of club members”				0.615
				(0.313)
Intercept	0.633***	0.560***	0.291**	– 2.715***
	(0.087)	(0.103)	(0.095)	(0.206)
Number of observations	837	837	837	837
Adjusted R-squared	0.01	0.02	0.13	0.33

Connoisseur if min 2 correct answers out of 3; at leisure center level. Errors clustered at leisure center level
p < 0.1, **p < 0.05, ****p < 0.01

Table 6 Characteristics of some European Museum Pass programmes

EU-15 countries (main cities)	AM-style Museum Pass and target population	Coverage	Price (2023)
Brussels	museumPASSmusées	Over 220 Belgian museums and a number of temporary exhibitions	€59
Copenhagen	None		
Berlin	None		
Helsinki	Museum Card	350 museums in Finland	€76
Paris	Paris Museum Pass	It is valid for 2, 4, 6 days and covers more than 60 museums	From €70
Athens	None		
Dublin	None		
Rome	MIC—reserved to people resident in Rome	Free entrance for one year to Museums of the city of Rome and related expositions	€5
Luxembourg city	Kulturpass—this pass is issued upon request to persons or families experiencing difficult economic circumstances	It is valid for two years and entitles holders to free admission to all Luxembourg City museums, and to purchase entry tickets to events organised by the City's cultural partners at €1.50 (per event and per person), within the limit of the number of places available	Free
Amsterdam	Museumkaart	More than 450 Dutch museums	€64.90
Vienna	None		
Lisbon	None		
Madrid	Tarjeta anual de Museos Estatales	Most of the museums in Madrid for free or for a reduced price	€36
London	National Art Pass in UK. It is a donation to the Art Fund, a charity that supports museums and galleries across the UK	240 art-related attractions, a vast number of which are located within the London area	£73
Stockholm	None		

incidence of volunteers and experts, confirming the opportunity to resort in our analysis to an ABM to better model the interactions among agents and simulate the effects of an enforcement of these interactions on the renewal probabilities.

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