Cultural heritage and economic development: measuring sustainability over time

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ABSTRACT

This study investigates the role of museums and cultural heritage in local development, highlighting their ability to attract tourists, generate revenue, and promote inclusion and cultural diversity. According to traditional economic theory, cultural heritage provides positive externalities, enhancing employment and improving human and social capital, all while adhering to principles of sustainability. In this context, the Italian Survey on Museums and Other Cultural Institutions offers extensive data on heritage conservation, accessibility, and visitor services. Utilising this longitudinal data, we conduct a latent transition analysis to examine the evolution of the Italian museum sector with a focus on regional differences and museums' dimension. Our findings classify Italian museums into three homogeneous sustainability states. Additionally, museum size positively affects both the initial and transition probabilities, while the macro-area significantly influences only the initial probability.

1. Introduction

In recent decades, a confluence of social, economic, and technological shifts has progressively reshaped the fundamental essence of museum organisations. This evolution has propelled them towards greater engagement in fostering social innovation and promoting territorial development, all while adhering to sustainability principles.

The connection between sustainability and heritage preservation is highlighted in the definition given by The International Council of Museums (ICOM), for which "[...] *sustainability is the dynamic process of museums, based on the recognition and preservation of tangible and intangible heritage with the museums responding to the needs of the community. To be sustainable, museums, through their mission, must be an active and attractive part of the community by adding value to the heritage and social memory.*" [1]. By this definition, the reference to the temporal evolution of the term is clearly evident, as well as the close link between sustainability, attractiveness and local development (also in terms of social inclusion).

However, the management of museums is not merely a custodial responsibility; the management of museums and cultural heritage can be traced back to some traditional concepts of economic theory [2]. These goods, in fact, satisfy needs that improve a country's civilisation level, providing positive externalities, as cultural heritage positively affects employment in economic sectors (such as tourism) and determines an improvement in human and social capital [3]. In this way, the ability of museums to achieve their purposes of conservation and valorisation of artistic and cultural heritage takes particular relevance. Beyond that, museums function as dynamic spaces for education, research, and cultural exchange. They contribute to enriching societal knowledge and inspire creativity, fostering a sense of continuity and interconnectedness with the past [4].

From an economic perspective, museums significantly influence a country's level of civilisation. The presence of well-managed museums enhances a nation's soft power [5], attracting global attention and fostering cultural diplomacy. The economic theory of cultural capital posits that investments in cultural institutions, like museums, yield returns in terms of enhanced societal well-being and economic prosperity. Moreover, museums can act as catalysts for urban development, attracting businesses, residents, and investments to surrounding areas and improving the cities' reputation [6].

In this context, the Italian Survey on Museums and Other Cultural Institutions, carried out by the Italian Statistical Institute (Istat), the Ministry of Cultural Heritage and Activities and Tourism, the Regions and the Autonomous Provinces since 2011, provides a wide range of information for museums and similar structures (https://www.istat.it/en/archivio/167568). The main research areas analysed are heritage conservation, accessibility to exhibition spaces, visitor orientation, and relations with the external context. The availability of longitudinal data allows not only to classify museums based on the available information but also to analyse the evolution of museum groupings over time, paying particular attention to territorial detail and museum size.

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Italy is an exemplary case study for examining the role of museums and cultural heritage in local development due to its rich and diverse cultural history. As a country renowned for its extensive collection of museums, archaeological sites, and cultural institutions, Italy provides a unique context in which to study the impacts of cultural heritage on economic and social outcomes. The Italian Survey on Museums and Other Cultural Institutions offers comprehensive and longitudinal data, allowing for an in-depth analysis of trends and changes over time. Additionally, Italy's regional diversity, with distinct cultural and economic profiles across different areas, provides a valuable opportunity to explore how local factors influence the sustainability and effectiveness of museums. By focusing on Italy, we can draw insights that are relevant not only to other countries with rich cultural heritages but also to regions aiming to leverage cultural assets for local development and economic regeneration.

Therefore, the present work aims to reach the following research objectives:

RQ1. **Classify museums by sustainability**: Define and classify Italian museums based on their sustainability practices.
RQ2. **Analyse temporal changes**: Investigate whether membership in the different groups has changed over time.
RQ3. **Investigate the impact of museums' features**: Understand whether certain "structural" variables, such as museum size and geographical location, have played a role in the membership and/or change.
RQ4. **Map territorial distribution of groups**: Visualise the geographic distribution of classified groups.

Despite the growing interest in the sustainability of cultural institutions, there are no studies in the literature aiming at classifying Italian museums based on their sustainability levels using quantitative indicators. Our study addresses this gap by employing a latent transition analysis to categorise museums into different sustainability classes. It is worth noting that this classification not only offers insights into the current status of the museums analysed but also provides a valuable tool for classifying museums that do not participate in the census survey every year. In other words, by leveraging the characteristics of museums that have been classified by the model, we can infer the sustainability status of similar institutions that were not directly surveyed. This approach allows for an ex-post classification, ensuring that even those museums not consistently captured in the annual survey can still be evaluated and monitored for sustainability. This capability is particularly crucial for creating comprehensive and continuous oversight of the museum sector, contributing to more informed and effective policy-making and resource allocation. Finally, another reason for focusing on the Italian case is the access to official and reliable data collected by Istat. In fact, this dataset offers authoritative and longitudinal information about Italian museums and cultural institutions, ensuring a robust foundation for our analysis.

The remaining part of the paper is organised as follows. In Section 2, we present the theoretical framework. Section 3 describes the statistical model. In Section 4, we illustrate the data under analysis and present some descriptive statistics. Section 5 is devoted to the results. Finally, the conclusions in Section 7 end the paper.

2. Theoretical framework

In recent years, policy makers have underlined the strategic value of cultural heritage to territorial development, economic growth and employment, as stated in the New European Agenda for Culture and in the European Heritage Strategy [7,8]. However, it is difficult to measure the magnitude of cultural heritage impact on the economy and territories. To properly understand the contribution that cultural heritage makes to the market and society, a common framework must be established in Europe for the collection of standardised and comparable data on cultural heritage. Cultural heritage information, in terms of indicators and classifications, might be important to make a strong argument for the value of cultural heritage for social and economic progress.

Museums are, above all, cultural destinations but they are also tourist destinations and thus have an impact on economic activity. Museums represent repositories of a nation's cultural wealth, safeguarding its heritage for present and future generations. In this vein, museums are a resource for local development [9]. Indeed, they can help attract tourists [10], generate revenue, and promote inclusion and cultural diversity, playing a fundamental role in preserving and promoting cultural heritage [11].

There is a strong relationship between museum activities and local (regional) tourism, as museum visitors' trips generate economic activity, which is related not only to museums but also to enterprises in the tourist industry, retail business, and many other destinations in the locality of museums.

Several international initiatives have emphasised the need to create objective (and synthetic) measures to monitor museums' sustainability over time and the fundamental role of cultural organisations in a region's sustainable development process [12]. However, despite the clear relationship between museums, culture, and sustainable development, little has been done on this topic.

In this vein, research on museums and sustainability has generally focused on defining the concept of museum sustainability and advocating for its integration into museum practices, exploring how various museum activities contribute to or can enhance sustainable development. For instance, the type of museum may influence its sustainability, as certain museums attract more visitors than others, potentially impacting their financial stability and community relevance. Indeed, museums are increasingly acknowledged as fundamental institutions for heritage and cultural preservation and their potential to advance broader societal goals, including sustainability [13].

In this regard, a significant contribution comes from [14], who investigated, through a qualitative approach (literature review and semi-structured interviews), the elements that could be used to define and measure a museum's level of sustainability.

The authors show the complex interplay of influences affecting museum sustainability. Highlighting governance structures as foundational to sustainability, they emphasise the role of organisational frameworks and decision-making processes in fostering adaptability and innovation. They also underscore the significance of financial considerations, advocating for diversified funding sources and strategic resource allocation to ensure long-term growth.

Moreover, sustainability in museums extends beyond financial concerns to encompass broader cultural and social dimensions. In this sense, it emerges as essential for sustainable growth to focus on practices in collection management, exhibition design, and facility operations. In other words, it is emphasised that museums must address environmental challenges. Therefore, the concept of sustainability has become fundamental to encouraging meaningful community relationships and promoting the role of museums as cultural exchange and dialogue hubs.

However, as [14] pointed out, the existing measures used to define and measure museums' sustainability should have considered comprehensive assessment frameworks capturing economic, environmental, and social indicators. Therefore, they proposed novel indicators regarding financial stability, environmental stewardship, community engagement, and cultural preservation. These indicators offer museums deeper insights into their operational strengths and weaknesses and facilitate their informed decision-making and strategic planning for the future.

Based on this framework and following the ICOM definition of museum sustainability, a classification of Italian museums is proposed. The availability of Istat longitudinal data allows to classify museums based on five sustainability dimensions, jointly with the changes in museums classification over time, paying particular attention to the role played by territories and museum size on the membership and transition probabilities. From a methodological point of view, a latent transition regression analysis is applied to these goals.

3. Method

Latent transition analysis (LTA) serves as a variant of the latent class model designed not only to capture latent class membership but also transitions in such membership over time [15].

Unlike in latent class analysis (LCA), where latent classes denote stable sets of characteristics or behavioural states, in LTA, individuals may transition between latent classes across time. Hence, within this framework, the term "latent status" is utilised instead of "latent class" [16], acknowledging that subgroup membership is not presumed to remain constant over time. Consequently, the model is termed a latent transition model.

In LTA three sets of parameters are estimated:

1. The probabilities of latent status membership are estimated for each time point;
2. The transition probabilities denoting the probability of transitioning from a particular latent status at time t to another latent status at time $t+1$, typically displayed in a matrix with the rows corresponding to the earlier time and the columns corresponding to the later time. These transition probabilities illustrate the probability of transitioning to the latent status indicated in the column, given prior membership in the latent status indicated in the row. Notably, the diagonal elements of this transition probability matrix signify the probability of remaining in a particular latent status at a given time, conditioned on being in that same latent status at the previous time;
3. A series of item-response probabilities delineates the relationship between the observed indicators of the latent variable at each time point and latent status membership, mirroring the manner in which factor loadings establish links between observed indicators and latent variables in factor analysis. That is, in addition to the number of classes and the size of classes being subject to change, it is interesting to locate the museums that are stayers (in the same class at each time) and those who are movers.

That is, further to the number of classes (and their sizes) being subject to change, we deemed it noteworthy to locate museums classified as *stayers* (in the same class at each time) and those who classified as *movers*, in terms of sustainability.

Moreover, akin to LCA, incorporating covariates into a latent transition model is essential. The aim of integrating covariates into the model is to discern attributes that forecast membership in various latent statuses and/or forecast transitions between latent statuses [17].

Let L_t represents the latent variable at Time t with S latent statuses, where $s_1 = 1 \ldots S$ at Time 1, $s_2 = 1 \ldots S$ at Time 2, and so on, up to $s_T = 1 \ldots S$ at Time T. In addition, there is a covariate X used to predict latent status membership at Time 1 and transitions between latent statuses at any two adjacent times. Then the latent transition model can be expressed as follows:

$$P(Y = y | X = x) = \sum_{s_1=1}^{S} \cdots \sum_{s_T=1}^{S} \delta_{s_1}(x) \tau_{s_2|s_1}(x) \ldots \tau_{s_T|s_{T-1}}(x)$$
$$\prod_{t=1}^{T} \prod_{j=1}^{J} \prod_{r_{j,t}=1}^{R_j} \rho_{j,r_{j,t}|s_t}^{I(y_{j,t}=r_{j,t})}, \tag{1}$$

where Y represents the response variables, $\delta_{s1}(x)$ is the marginal probability of class membership at the initial time $s = 1$, $\tau_{s2|s1}(x)$ denotes the probabilities of transition to a latent state conditionally on the previous latent state membership, $r_{j,t} = 1, \ldots, R_j$ refers to the categories of item j at time t, with $j = 1, \ldots, J$ indicating the items and $t = 1, \ldots, T$ indicating the times, and $\rho_{j,r_{j,t}|s_t}$ represents the probability of response $r_{j,t}$ to item j at time t conditionally on the membership to latent state s at time t. $I(y_{j,t} = r_{j,t})$ is an indicator function equal to 1 if $y_{j,t} = r_{j,t}$ at time t, and equals to 0 otherwise.

Therefore, Eq. (1) expresses how the probability of observing a particular vector of responses, conditioning to X is a function of the probabilities of membership in each latent status at Time 1 (δ_{s_1}) affected by the covariate *(x)*, the probabilities of transitioning to a latent status at a particular time conditional on latent status membership at the immediately previous time (τ), and the probabilities of observing each response at each time conditional on latent status membership (ρ). The parameters ρ express the relationship between each manifest variable (or indicator) and each latent class — which is to say that item response probabilities indicate how units can be classified into the specified latent classes, given their manifest variable values [18].

Item response probabilities and latent class membership can help accurately categorise museums into a specific class (or status). Using the LTA also allowed us to observe stability and change in the latent classes, which was useful for identifying stayers (those in the same class at each wave) and the number of movers.

In the process of model specification, a major concern in LTA (as in LCA) is choosing the number of latent states to retain. This is done by considering the parsimony and interpretability of the possible solutions, while seeking to give substantial meaning to the identified latent status [19,20]. In order to determine the optimal number of latent states, it is useful to estimate different models specifying a different number of states. The final is the model with the lowest BIC (Bayesian information criterion) value or with the lowest AIC (Akaike information criterion) [15].

To perform the model, we used the LMest package [21] implemented in the R statistical software.

4. Data

The Italian Survey on Museums and Other Cultural Institutions, carried out by the Italian Statistical Institute (Istat), the Ministry of Cultural Heritage and Activities and Tourism, the Regions and the Autonomous Provinces since 2011, provides a wide range of information for museums and similar structures useful to describe the development path of cultural heritage on sustainable socio-economic growth.

In the following a brief description of data used in our analysis.

4.1. The Italian survey on museums and other cultural institutions

The Italian Survey on Museums and Other Cultural Institutions is a census survey that aims to obtain and release data on museums and cultural institutions. Each year, the data collected describes about 4,500 museums, with a response rate ranging from approximately 90% to 95%.

Following the initial editions based on a four-year rotation principle (e.g., 2007, 2011, and 2015), the survey has transitioned to an annual conduct since 2017, supported by the project for regional and sectoral statistics for the 2014–2020 cohesion policies, funded through EU cohesion policy financing.

The survey conducted annually by Istat offers an updated and detailed description of all the museums and other museum-related structures present in Italy, that is, of all those permanent structures open to the public that acquire, conserve, communicate and exhibit, non-profit, for study, education and pleasure, goods and collections of cultural interest, whether public or private, state or non-state, as long as they are equipped with services organised for use.

The data pertain to museums, galleries, collections, archaeological sites and parks, monuments, and monumental complexes (both public and private) surveyed annually through the Istat survey.

The data is gathered using a web questionnaire and published on the Istat's website. The questionnaire covers different dimensions related to the museums, such as what kind of supports (audioguide and videoguide, QR code, application for smartphones or tablets) and services (such as the possibility to book the ticket online or if there is a car park) they can provide to the visitors, financial aspects (if the museum has received public or private funding), information about the collections exhibited (like, how many goods are exposed), and so on.

Table 1
Distribution of the museums that answered the questionnaire in 2018, 2019, and 2021.

Region	2018	2019	2021
Abruzzo	108	110	84
Basilicata	48	49	42
Calabria	166	163	134
Campania	233	227	199
Emilia-Romagna	454	458	424
Friuli-Venezia Giulia	175	170	145
Lazio	357	349	298
Liguria	194	197	156
Lombardia	433	419	373
Marche	291	282	254
Molise	41	43	34
Piemonte	411	414	352
Puglia	164	142	131
Sardegna	290	307	265
Sicilia	260	241	220
Toscana	553	580	511
Trentino-Alto Adige	201	200	183
Umbria	165	170	161
Valle d'Aosta	60	60	46
Veneto	304	299	280

4.2. Descriptive statistics

For our aims, we use the data carried out by the Survey on Museums and Other Cultural Institutions for the years 2018, 2019 and 2021. The year 2020 is not included in the analysis as it mainly focused on the Pandemic sanitary measures adopted by the museums.

Table 1 shows the distribution of the museums that answered the questionnaire in the years under analysis.

As it is possible to observe, the number of museums and cultural institutions that answered the questionnaire is similar for all the years considered. More specifically, the data collected documents an Italian heritage quantifiable in about 4 thousand museums (from 78% to 80% in the years considered), archaeological areas (about 7% of the total each year), monuments (from 13% to 15% in the years considered) and ecomuseums (recorded only in 2018 and representing about 1.4% of the total) open to the public.

It is a heritage spread throughout the territory: in more or less one Italian municipality in three, there is at least one museum structure. Generally, the majority are museums, galleries or collections, followed by monuments and monumental complexes, archaeological areas and parks and ecomuseum structures.

Toscana, Emilia-Romagna, Lombardia, Piemonte, Lazio, and Veneto are the regions with the highest concentration of structures including museums, archaeological areas and monuments while Roma, Firenze, Torino, Milano, Bologna, Trieste, Genova, Napoli, Venezia and Siena are the top 10 cities with the highest number of the historical-cultural, architectural, and archaeological richness of Italy. However, the territorial differences and the type of structure are significant.

From the three surveys, we detected five dimensions of the sustainability (following the definition proposed in [14]) of the museums: *services*, related to the facilities made available for the public; *supports*, regarding supports made available to visitors for the visit; *activities*, that is, the activities organised by the museums for the visitors; *web*, namely museum products and services available on the web; *digitalisation*, related to the process of digitalisation of the assets the museums own.

These dimensions were measured using different items every year. Therefore, to obtain a singular indicator which we could use to measure them over the years, we aggregated the items composing each dimension by summing the answers and dividing the result by the number of items composing the dimensions. We were able to do that because all the variables were indicator variables (or were transformed into indicator variables). Table 2 shows the descriptive statistics of the

five indicators per year, while Tables 8–10 in the Appendix show the variables which were synthesised per year.

About the covariates which could influence the initial and transition probabilities, we included in the analysis the *macro-area*, dividing the regions into five geographical areas, that is, North-West (Liguria, Lombardia, Piemonte, Valle d'Aosta), North-East (Emilia-Romagna, Friuli-Venezia Giulia, Trentino-Alto Adige, Veneto), Center (Lazio, Marche, Toscana, Umbria), South (Abruzzo, Basilicata, Calabria, Campania, Molise, Puglia), and Island (Sardegna and Sicilia), and the *size* of the museums, a variable with three levels (small, medium, and large) obtained by considering the quartiles of the distribution of the numbers of workers employed in the museums. The variable macro-area, whose structure into five categories is consistent with the Eurostat NUTS-1 classification (https://ec.europa.eu/eurostat/web/nuts), is constant over the years, while the variable size can vary over time.

The selection of the macro-area of belonging and museums' size as covariates is essential due to their significant influence on the sustainability of museums. The macro-area of belonging, which divides Italy into geographical regions, captures regional differences in culture, economy, and administration that affect museum operations, funding, visitor demographics, and strategic priorities. Museums in wealthier regions may start with higher sustainability due to better funding and support, while regions with strong economic growth and effective cultural policies might see more museums improving their sustainability over time. On the other hand, museums' size influences resources, operational capacity, and strategic capabilities. Larger museums are expected to start with higher sustainability levels due to greater financial resources and extensive support networks, and they are more likely to improve their sustainability further through investments in infrastructure and programming. Smaller museums may have difficulties initially but can benefit from targeted support and strategic partnerships to enhance their sustainability. Including these covariates helps understand the impacts of regional context and institutional capacity on the sustainability trajectories of museums, showing if the improvement in the museums' sustainability practice could be ascribed to exogenous or endogenous factors, providing insights for tailored policy interventions and support strategies.

The number of museums interviewed in every year analysed, identified by their name and address, equals 1,936. Among these, the majority of the museums coded as small and medium are located in the Center of Italy (about 23% and 35%, respectively), while the majority of the museums coded as large are located in the North-West of Italy (about 30%). These results are generally consistent each year.

5. Results

In this paragraph empirical findings from the latent transition model are discussed.

First of all, to select a suitable number of latent states to retain, we estimated the model without covariates and with homogeneous transition probabilities, and selected the model with the lowest BIC and AIC values. Fig. 1 shows the comparison between BIC and AIC for a number of latent states ranging from 1 to 7, based on which we selected the model with 3 latent states.

Then, we estimated the model, including the covariates and keeping the number of latent states fixed at 3. Tables 3–5 show the estimated conditional response means of the dimensions identified under this model, initial probabilities, and transition probabilities. The latter are also shown in Fig. 2. We did not report the graph of the transition probabilities obtained under the null model as very similar to the one obtained from the model with the covariates.

Considering that it is always possible to order the states according to the informative content of the application, based on Table 3 we ordered the states according to increasing sustainability levels, represented by the dimensions identified. Therefore, museums in the first group show lower sustainability levels, depicted by lower values in each dimension.

Table 2
Descriptive statistics of the five indicators *services*, *supports*, *activities*, *web*, and *digitalisation* per year.

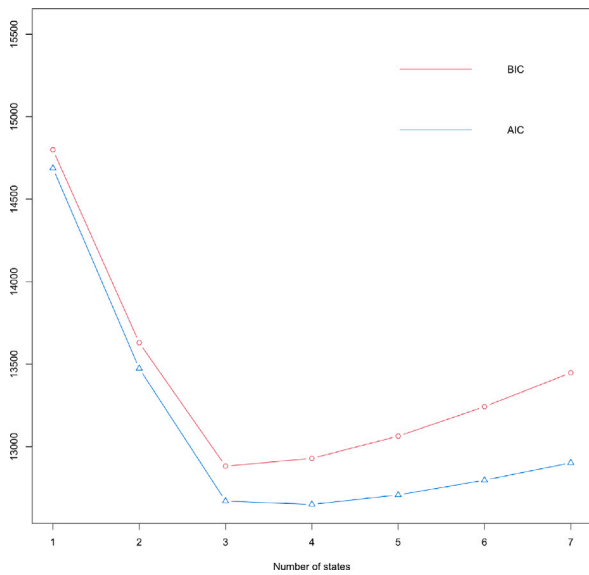| Year	2018				2019				2021			
Item	Min.	Max.	Mean	Dev. Std.	Min.	Max.	Mean	Dev. Std.	Min.	Max.	Mean	Dev. Std.
services	0	1	0.34	0.23	0	1	0.40	0.32	0	1	0.47	0.37
supports	0	1	0.44	0.22	0	1	0.40	0.22	0	1	0.23	0.28
activities	0	1	0.63	0.34	0	1	0.64	0.35	0	1	0.50	0.32
web	0	1	0.34	0.26	0	1	0.38	0.30	0	1	0.28	0.26
digitalisation	0	1	0.29	0.34	0	1	0.54	0.50	0	1	0.41	0.45

Fig. 1. AIC and BIC criteria for a number of latent states ranging from 1 to 7 in the model without covariates.

Table 3
Estimated conditional response means under the model with covariates with k = 3 latent states.

| Latent states | 1 | 2 | 3 |
Item			
services	0.1836	0.3661	0.6269
supports	0.1996	0.3327	0.5453
activities	0.3449	0.6113	0.8067
web	0.1601	0.2979	0.5428
digitalisation	0.5753	0.7197	0.8142

Table 4
Estimated initial probabilities under the model with covariates with k = 3 latent states.

Latent states	1	2	3
Initial probabilities	0.3217	0.3590	0.3194

Table 5
Estimated transition probabilities under the model with covariates with k = 3 latent states.

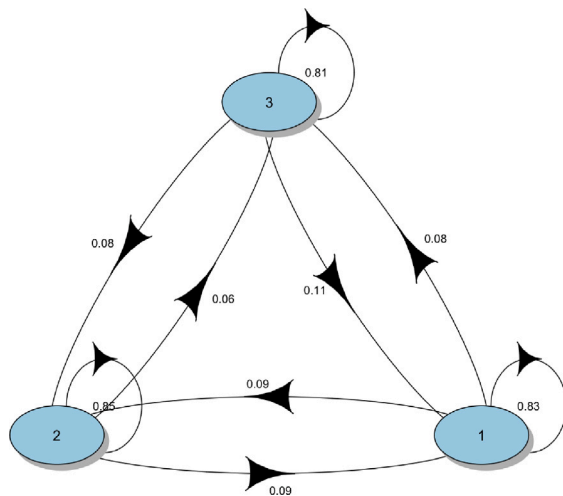| Latent states	1	2	3
1	0.8448	0.0876	0.0675
2	0.0929	0.8488	0.0583
3	0.1086	0.0777	0.8137

Fig. 2. Averaged transition probabilities under the model with the covariates with k = 3 latent states.

Conversely, states 2 and 3 are those of museums with a medium and high level of sustainability, respectively. In particular, those in state 3

have higher levels in each dimension, showing higher effort in investing in competitive advantage.

From Table 4, the probability of belonging to a latent state is homogeneous, with about 30% of the museums in each state. In Table 5 the probability of transition between states is reported. There is a high probability of remaining in the same latent state (about 85% for the first two states and 82% for the third). Noteworthy, a slight shift is found from state 3 to state 1 (about 11%), whilst museums characterised by a low-medium level of sustainability (states 1 and 2) mainly move into the closest categories (low versus medium, medium versus low).

Table 6 provides the estimated regression parameters of the initial probabilities. In this context, the estimated North-East macro-area parameter is positive and significant for latent states 2 and 3, indicating that the probability of being in one of these latent states at the beginning of the study is higher for museums located in the North-East of Italy with respect to the museums located in the North-West. On the contrary, museums located in the South of Italy have a lower initial probability of being in the latent state 2 compared to those located in the North-West of Italy. About the size, all the estimated regression coefficients are positive and significant, meaning that the probability for medium and large museums to be in latent states 2 and 3 at the study's beginning is higher than in latent state 1 with respect to small museums.

Regarding the covariates that affect the transition through the latent states, Table 7 shows that only the size of the museums influences these probabilities. More specifically, we observed that the increase in the size of the museums corresponds to higher transition probabilities from

Table 6

Estimates of the regression parameters of the initial probability to belong to the other latent states with respect to the first state under the model with 3 latent states. In bold are the significant regression parameters for $\alpha = 0.05$.

Effect		$\hat{\beta}_{12}$	$\hat{\beta}_{13}$
Macro-area ref: *North-West*	North-East	**0.3596**	**0.6034**
	Center	0.2065	0.2936
	South	**−0.3684**	**−0.4129**
	Island	−0.2358	−0.4192
Size ref: *Small*	Medium	**0.9522**	**1.6127**
	Large	**1.4343**	**3.1067**

Fig. 4. Cartogram of the museums belonging to state 2 in 2018 per province.

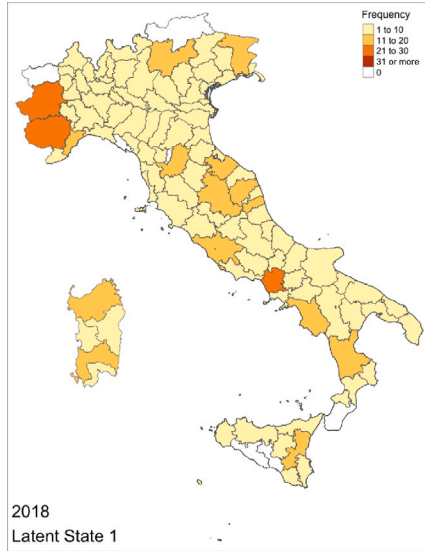**Fig. 3.** Cartogram of the museums belonging to state 1 in 2018 per province.

Fig. 5. Cartogram of the museums belonging to state 3 in 2018 per province.

state 1 to states 2 and 3. The contrary can be stated for the transition probabilities from state 3 to states 2 and 1 and the transition probability from latent state 2 to state 1.

Generally, about 16% of the museums show a movement through the latent states in the years considered. In particular, the museums in the South of Italy and the Islands show higher transitions, with a percentage of 21% and 24%, respectively. Follow the North-West and North-East of Italy, with a percentage of museums that transit to another latent state of about 14%. In the Center of Italy, the percentage is 13%. In particular, the museums located in the North-East, Center, and South of Italy show, in percentage, higher transitions from lower states to higher ones in the years 2018–2019, while in the years 2019–2021, the highest percentage of movements through lower states to higher ones are shown by the museums located in North-East, North-West, Center, and South Italy.

Regarding the transitions from higher to lower states, in the years 2018–2019, the museums located in the South of Italy and the Island show the higher percentage of the transitions. In the years 2019–2021, museums with a higher percentage of transitions between higher to lower states were located in the North-West, Center of Italy, and the Island. In more depth, the regions that showed the majority of movements in 2018–2019 from lower latent states to higher are Emilia-Romagna, Lombardia, Toscana, Piemonte, Puglia, and Sardegna. In 2019–2021 are Calabria and Piemonte. On the contrary, the regions that move significantly to a lower state in 2018–2019 are Emilia-Romagna and Sardegna, while in 2019–2021, they are Emilia-Romagna,
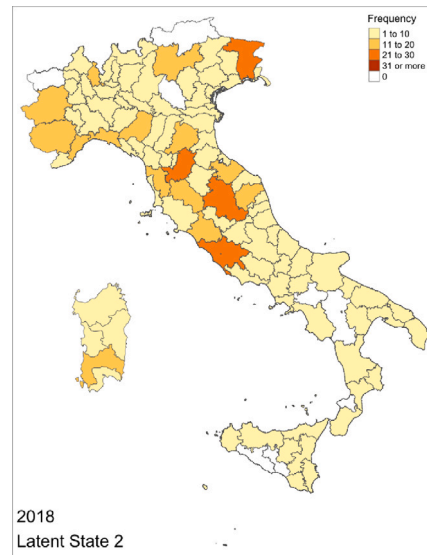
Piemonte, Puglia, and Sardegna. Table 11 in Appendix illustrates the percentage of museums that show a transition between the latent states per region for the years 2018–2019 and 2019–2021. Examples of museums that show significant transitions through the states, for example, from state 3 to state 1, are the Museo del Bergamotto in Calabria or the Casa Museo "Gaia da Camino" in Veneto. On the other hand, some examples of museums that show movements from state 1 to state 3 are the Museo Diocesano in Campania and the Museo Civico di Bari in Puglia.

Figs. 3–5 show the provincial distribution (with ten elements in each class to make the representation more straightforward) of the museums for each latent state in 2018. The museums clustered in the first latent state are distributed throughout the national territory. Conversely, the museums belonging to latent states 2 and 3 are mainly concentrated in

Table 7

Estimates of the regression parameters of the transition probabilities under the model with 3 latent states. In bold are the significant regression parameters for $\alpha = 0.05$.

Effect		$\hat{\gamma}_{12}$	$\hat{\gamma}_{13}$	$\hat{\gamma}_{21}$	$\hat{\gamma}_{23}$	$\hat{\gamma}_{31}$	$\hat{\gamma}_{32}$
Macro-area ref: *North-West*	North-East	0.171	−0.273	−0.162	0.040	−0.316	−0.228
	Center	0.073	−0.226	−0.081	0.040	−0.358	−0.237
	South	0.292	0.654	0.058	0.330	0.386	−0.254
	Island	−0.115	−0.566	0.449	−0.370	1.096	0.364
Size ref: *Small*	Medium	0.929	**1.740**	**−0.937**	0.570	**−2.195**	−0.776
	Large	**1.446**	**2.993**	−1.268	1.080	**−3.391**	**−1.432**

the Center and North of Italy. Similar results were observed in 2019 and 2021 (Fig. 6 in Appendix).

Finally, regarding the size of the museums, about 17% of the museums coded as small show transitions across the latent states over the years. Similarly, about 14% of the museums coded as medium, and 16% of museums identified as large show movements through the latent states in the years under analysis.

6. Discussion

Museums and cultural heritage sites represent a powerful resource for local development. They can inspire and help regenerate local economies, attract visitors, and bring in revenue. There is also growing evidence that they can contribute to social cohesion, civic engagement, health, and well-being. For several decades now, cities and regions have drawn on these resources to implement heritage-based actions as part of their broader economic development strategies. National, municipal, and regional governments, the museum community, and other stakeholders are increasingly interested in these issues.

Sustainability, and all its variations, is an open challenge with which many museums and places of culture have yet to deal systematically. It is a process that began a few years ago but is struggling to find widespread application. The development of an overall strategy through public policies at local, regional, and national levels is still at an early discussion stage.

As the International Council of Museums (ICOM) has pointed out, the contribution of museums to sustainable development is now an essential element of its agenda. According to [1], "*[...] sustainability is the dynamic process of museums based on the recognition and preservation of tangible and intangible heritage with the museums responding to the needs of the community. To be sustainable, museums, through their mission, must be an active and attractive part of the community by adding value to the heritage and social memory.*".

Culture and the museum sector can make a contribution to numerous Sustainable Development Goals (SDGs) for the United Nations 2030 Agenda related to the main challenges facing contemporary society, starting with Target 11.4, within Goal 11 "Cities and sustainable communities" which concerns the strengthening of efforts to safeguard cultural and natural heritage and its connection with socioeconomic development (above all) at a territorial level. Thanks to their widespread presence in the territory, museums constitute a cultural infrastructure and are in relation to the urban and territorial context.

It is precisely this last aspect, of integration with territorial policies, that requires in-depth work and where a great opportunity for growth could open up, with the possibility of museums interacting with the bodies responsible for defining policies for sustainable development oriented towards local development. But, to date, there is considerable difficulty in finding quantitative information on museums and their characterisation at the territorial level. In this sense, the Italian Survey on Museums and Other Cultural Institutions represents a valuable source of reliable information that can be used, on the one hand, to classify Italian museums to group them by different sustainability values and evaluate (possible) changes over time. To this goal, latent transition models help us group museums into specific classes (or status) and understand stability and change within these sustainability latent classes over time. This involves identifying museums that remain in the same state across years and those that move between states. On the other hand, this classification could be employed to classify a-posteriori museums not involved in all the questionnaire administrations, representing in this way a valuable tool for inferring the sustainability status of similar institutions that were not directly surveyed.

Therefore, by using data carried out by the Italian Survey on Museums and Other Cultural Institutions, for the years 2018, 2019, and 2021, we found that Italian museums are divided into three homogeneous classes. After having defined and computed five (possible) dimensions of museums' sustainability, the main empirical findings suggest (i) that museums show a tendency to remain in the same state in the period selected, (ii) the territorial area in which the museum is located and its size both affect the probability to being in a specific class at the beginning of the study and (iii) only the size of the museum affects the probability to move from a state to another in the period here considered. Although some of our empirical findings are noteworthy, it could be interesting to consider additional dimensions and/or other museum covariates, jointly with a greater level of territorial disaggregation (e.g., at the provincial level) which allows for a more in-depth analysis of local development.

7. Conclusions

This paper proposes a classification of Italian museums to group them by different sustainability values and evaluate possible changes over time. By employing a latent transition analysis, we were able to group museums into specific classes and understand stability and change within these sustainability latent classes over time. Using data from the Italian Survey on Museums and Other Cultural Institutions for the years 2018, 2019, and 2021, we found that Italian museums can be divided into three homogeneous classes. In addition, our findings suggest that museums tend to remain in the same state over the selected period, the territorial area and museum size both affect the probability of being in a specific class at the beginning of the study, and only the size of the museum affects the probability of moving from one state to another during the period considered.

However, it should be noted that to measure the five dimensions of sustainability, different items were used for each year due to changes in survey questionnaires. This discrepancy means that the dimensions do not completely overlap over time, representing a limitation of our study. While the core aspects of sustainability are consistently targeted, the inconsistency in specific survey items may introduce some variability in the measurements. Acknowledging this limitation is crucial for interpreting our findings and highlights the need for developing more standardised and consistent measurement frameworks in future research.

Table 8
Variables measured in the context of the Italian Survey on Museums and Other Cultural Institutions conducted by Istat in 2018 and used to create the indicators *services*, *supports*, *activities*, *web*, and *digitalisation*.

Dimension	2018
Services The following services were available to the public:	Booking of tickets and visits Parking Cloakroom Cafeteria and restaurant Food and drink vending machines Furnished spaces for visitors to park Bookshop Free Wi-Fi Reception and entertainment for children (playrooms, etc.) Assistance for disabled visitors Facilities for disabled visitors Other
Supports The following visiting supports were available:	Reception point for information and orientation Information panel and/or map of the visit routes at the entrance Signage to indicate the visit routes Paper information material (brochures, leaflets, mobile cards, etc.) Panels and/or captions for describing the individual works Audio and/or video guides Applications for smartphones and tablets Interactive displays and/or virtual reconstructions (touch screen, video...) QR Code and/or proximity systems (Bluetooth, Wifi, etc.) Tablets available to the public Video/multimedia room Routes and information materials dedicated to children Materials and information support to encourage use by disabled people Complete name of the institute outside the headquarters Indication of the opening hours outside the office Signage – informative, directional and identifying – outside the premises, on the roads approaching the structure
Activities The museum/institute carried out:	Exhibitions and/or temporary exhibitions Educational workshops Guided tours
Web The following web services were available:	Dedicated website Catalogue accessible online for visitors Online ticketing service Possibility to visit virtually the museum/institute via the Internet Social media accounts (Facebook, Twitter, Instagram, Pinterest, Foursquare, etc.) Links to digital maps and/or geographic coordinates for location
Digitalisation The museum/institute has:	A digital inventory A digital scientific catalogue

The findings of this study provide valuable insights that can significantly inform museum policy from local, regional, and national perspectives. By categorising Italian museums based on their sustainability levels and examining changes over time, policymakers can better understand the stability and dynamics within the museum sector. This understanding allows for targeted interventions to enhance sustainability practices across museums. Specifically, the study's results highlight the influence of geographic location and museum size on sustainability, suggesting that tailored strategies may be necessary for different regions and museum sizes. Recognising the tendency of museums to remain in the same sustainability state underscores the need for consistent and long-term policy support to encourage progress. Integrating these findings into policy frameworks can help develop more effective programmes that preserve cultural heritage and promote local development, economic regeneration, and social cohesion. Additionally, expanding the analysis to include additional dimensions and finer territorial disaggregation could provide more insights, enabling policymakers to elaborate more specific and significant cultural policies that align with the Sustainable Development Goals (SDGs) and foster sustainable community growth.

CRediT authorship contribution statement

Carla Galluccio: Formal analysis, Data curation. **Francesca Giambona:** Supervision, Project administration, Methodology, Conceptualization.

Data availability

Data will be made available on request.

Acknowledgement

Appendix

See Tables 8–11 and Fig. 6.

Table 9

Variables measured in the context of the Italian Survey on Museums and Other Cultural Institutions conducted by Istat in 2019 and used to create the indicators *services*, *supports*, *activities*, *web*, and *digitalisation*.

Dimension	2019
Services The following services were available to the public:	Free Wi-Fi connection in the exhibition area Spaces and/or facilities for children (reception and/or entertainment, playrooms, changing tables, etc.) Spaces and/or facilities for disabled visitors (e.g. equipped bathrooms, ramps, elevators, etc.)
Supports The following visiting supports were available:	Paper information material (brochures, leaflets, mobile cards, etc.) Information panel and/or map of the visit routes at the entrance Signage to indicate the visit routes Panels and/or captions for the description of the individual works Audio guides and/or video guides Applications for smartphones and tablets Video and/or touch screen Multimedia supports (interactive displays, virtual reconstructions, augmented reality, etc.) QR Code and/or proximity systems (Bluetooth, Wifi, etc.) Tablets available to the public Routes and information materials dedicated to children Information supports to facilitate visits by disabled people Information outside the office on opening hours Signage outside the headquarters on the roads approaching the structure
Activities The museum/institute carried out:	Guided tours Educational workshops (e.g. activities for children, teenagers and school groups) Assistance for disabled visitors
Web The following web services were available:	General information on access methods (e.g. address, timetables, fares, routes, etc.) Information on educational activities/workshops Information on events and/or temporary exhibitions User services (e.g. purchase of tickets, booking visits, purchase of gadgets and/or books, etc.) Links to access social media Link to digital maps and/or geographical coordinates for locating the office Catalogues in digital format of the assets owned (photos, videos, databases, etc.) Information on the research activities carried out (e.g. publications and research projects) Information on collaboration or partnership projects with third parties (e.g. museum or tourist networks and/or circuits) Exhibitions or virtual tours Social media account (Facebook, Twitter, YouTube, Instagram, Flikr, Linkedln, Pinterest, Foursquare, etc.)
Digitalisation The museum/institute has:	A digital collections (partially o totally)

Table 10

Variables measured in the context of the Italian Survey on Museums and Other Cultural Institutions conducted by Istat in 2021 and used to create the indicators *services*, *supports*, *activities*, *web*, and *digitalisation*.

Dimension	2021
Services The following services were available to the public:	Room/laboratory for teaching, study, research and/or conference activities Video/multimedia room Free Wi-Fi connection
Supports The following visiting supports were available:	Applications for smartphones and tablets Video and/or touch screen Multimedia supports (interactive displays, virtual reconstructions, augmented reality, etc.) QR Code and/or proximity systems (Bluetooth, WiFi, etc.) Tablets available to the public
Activities The museum/institute carried out:	Educational workshops (for children, teenagers and school groups) Thematic and/or educational tours specifically dedicated to children Guided tours Conferences, conferences and seminars Live shows and/or cultural entertainment initiatives Exhibitions and/or temporary exhibitions
Web The following web services were available:	Online ticketing service (for booking visits, purchasing tickets, etc.) Social media accounts (Facebook, Twitter, YouTube, Instagram, Pinterest, etc.) Online virtual tours Online guided tours and/or alternative online methods of visiting the museum/institute Online educational workshops (for children, teenagers and school groups) Online conferences, conferences and seminars Catalogues of the heritage owned in digital format (photos, videos, databases, etc.)
Digitalisation The museum/institute has:	Digital assets displayed to the public It movable assets digitalised

Table 11

Percentage of museums that show a transition between the latent states per region for the years 2018–2019 and 2019–2021. The percentages are computed with respect to the total of museums that show a movement (and not the total of museums under analysis). Here, "S" means "latent state", while "S1-S2", for example, means "transition from latent state 1 to latent state 2".

| Year	2018–2019						2019–2021					
Latent states	S1-S2	S2-S3	S1-S3	S2-S1	S3-S2	S3-S1	S1-S2	S2-S3	S1-S3	S2-S1	S3-S2	S3-S1
Region												
Abruzzo	3.3	0.0	5.3	0.0	0.0	7.1	2.9	4.5	0.0	0.0	0.0	0.0
Basilicata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calabria	0.0	5.0	5.3	5.0	0.0	14.3	14.7	0.0	0.0	1.6	0.0	5.0
Campania	0.0	0.0	5.3	7.5	0.0	0.0	8.8	4.5	0.0	3.2	2.8	10.0
Emilia-Romagna	6.7	20.0	0.0	10.0	8.3	14.3	8.8	13.6	16.7	11.1	11.1	15.0
Friuli-Venezia Giulia	3.3	5.0	0.0	5.0	8.3	0.0	8.8	0.0	8.3	4.8	0.0	0.0
Lazio	0.0	5.0	10.5	10.0	8.3	7.1	5.9	0.0	25.0	6.3	8.3	5.0
Liguria	6.7	0.0	21.1	2.5	8.3	0.0	0.0	9.1	0.0	0.0	11.1	0.0
Lombardia	0.0	20.0	21.1	5.0	8.3	7.1	5.9	13.6	8.3	9.5	11.1	0.0
Marche	6.7	0.0	0.0	5.0	0.0	14.3	5.9	4.5	0.0	4.8	0.0	5.0
Molise	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0
Piemonte	16.7	15.0	26.3	17.5	0.0	7.1	11.8	9.1	8.3	6.3	11.1	15.0
Puglia	13.3	0.0	10.5	5.0	0.0	7.1	2.9	4.5	16.7	6.3	0.0	5.0
Sardegna	13.3	5.0	10.5	7.5	33.3	7.1	2.9	0.0	0.0	19.0	11.1	20.0
Sicilia	3.3	0.0	5.3	2.5	8.3	7.1	8.8	4.5	8.3	12.7	0.0	10.0
Toscana	20.0	20.0	5.3	10.0	8.3	0.0	5.9	22.7	0.0	12.7	5.6	0.0
Trentino-Alto Adige	3.3	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	1.6	2.8	0.0
Umbria	0.0	5.0	0.0	0.0	0.0	0.0	0.0	9.1	8.3	4.8	8.3	0.0
Valle d'Aosta	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Veneto	3.3	0.0	0.0	2.5	8.3	7.1	2.9	0.0	0.0	3.2	16.7	10.0
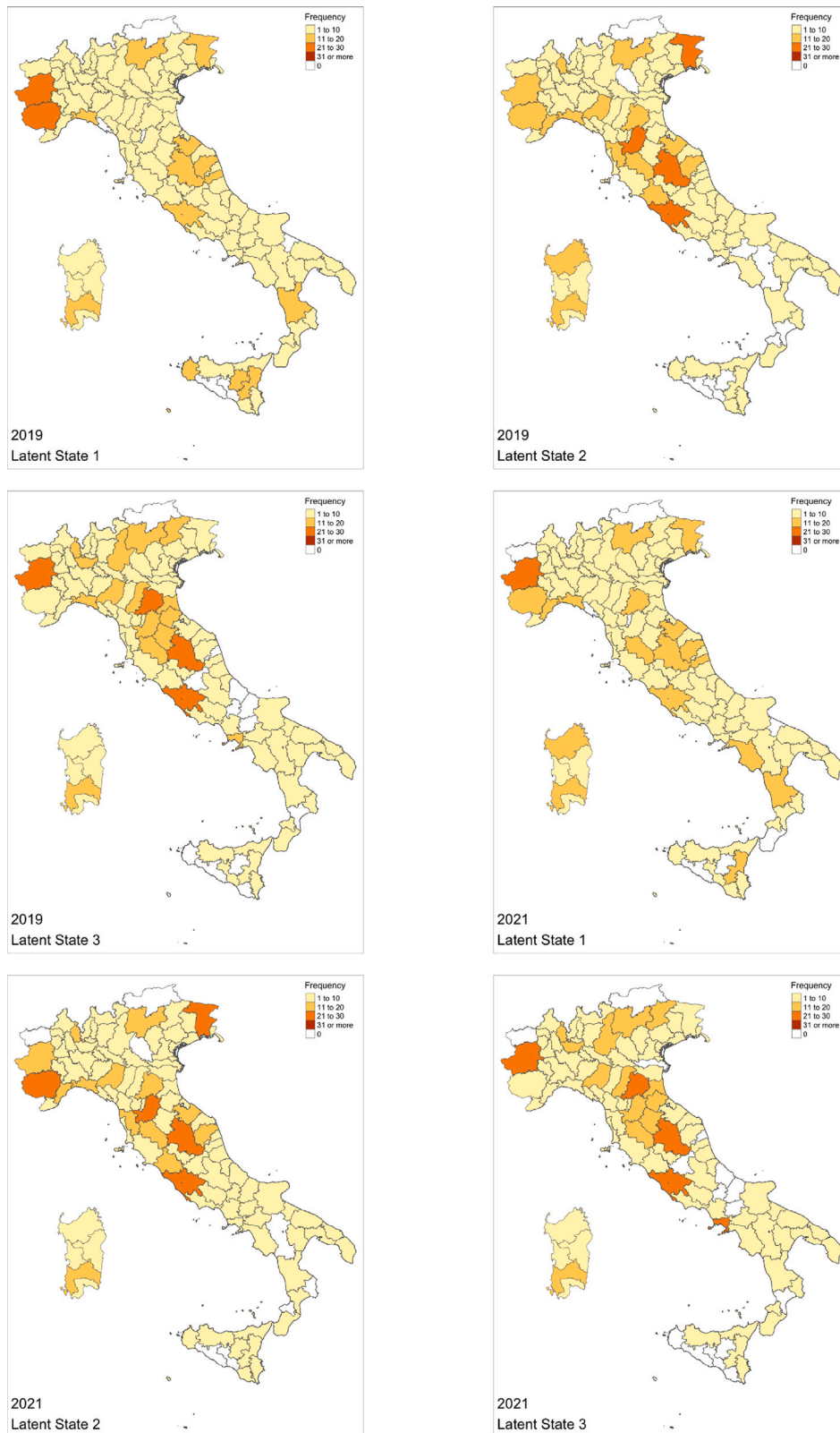
Fig. 6. Cartograms of the museums belonging to states 1 to 3 in 2019 and 2021 per province.

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