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ORIGINAL PAPER

Uncovering the impact of cultural heritage on economic growth: empirical evidence from Greek regions, 2000–2019

Ioannis Kostakis[1] · **Sarantis Lolos**[2]

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Abstract

This paper brings empirical evidence on the role of cultural heritage assets in promoting economic growth. The case of Greece at regional level over the period 2000–2019 is taken as an example, owing to important cultural heritage endowment. Economic growth is approached by formulating a neoclassical growth model augmented with a dynamic cultural heritage index. The relationship between economic growth and cultural heritage is examined through a heterogeneous and cross-correlated panel data analysis. The empirical results reveal a positive impact of cultural heritage endowment on economic growth. Also, a significant positive influence of physical capital and a negative impact of unemployment on the economy are evidenced. The conclusions drawn could be useful to regions and countries to upgrade their cultural heritage endowment to accelerate economic growth.

Keywords Cultural heritage · Regional economic growth · Panel data · Greece

JEL Classification Z1 · O47 · P25

✉ Ioannis Kostakis
ikostakis@hua.gr

[1] Department of Economics and Sustainable Development, Harokopio University of Athens, 70 Eleftheriou Venizelou, 176 76 Athens, Greece

[2] Department of Economic and Regional Development, Panteion University, Athens, Greece

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1 Introduction

Cultural heritage is of outmost importance, affecting various aspects of people's lives. The European cultural heritage is a primary resource for democratic engagement supporting cultural diversity and sustainable development. It represents cultural capital from which future cultural, social and economic development may be generated (Faro Convention 2005).[1] In the European context, cultural heritage has been recognised as an advantage and an engine of growth. The European Union focuses on cultural positive contribution to Europe's societies and economies and is committed to promoting, restoring, and conserving cultural heritage. The role of cultural heritage became crucial in achieving innovative, sustainable and inclusive growth in the "Europe 2020" strategy (European Commission 2010), while in "Getting cultural heritage to work for Europe" (European Commission 2015), cultural heritage is considered as a production factor and an important resource for innovation, social inclusion and sustainability. It is also considered a means of improving economic performance, people's lives and living environments. Also, in the "New European agenda for culture" (European Commission 2018) it was decided to strengthen the European Union's cultural dimension further.

The role of cultural heritage in economic development has gained more and more interest in recent years. Many researchers realize the positive contribution of culture and cultural heritage to economic growth and argue that cultural variables can increase the explanatory power of the classic econometric model. They propose that cultural variables must be treated as important causal variables and they incorporate cultural factors, such as cultural capital, into formal behavioural models of economic growth and development (Throsby 1999; Granato et al. 1996; Altman 2001). Many studies evaluate the economic impact of cultural heritage on economic growth but formal empirical analysis is limited. Most econometric studies investigate the impact of cultural heritage on growth directly or through its relation to tourism demand. In these cases, cultural heritage assets are usually proxied by "the number of UNESCO's World Heritage Sites (WHS)" situated in a country/region, where WHS are treated as a time-invariant *structural* variable (Faria and León-Ledesma 2008). Cultural heritage assets started to be considered as elements of territorial attractiveness, differentiation, competitiveness, and cultural heritage and tourism began to be considered inextricably linked (OECD 2008).

This paper aims to empirically bring out the role of cultural heritage endowment as a driver for economic growth. The impact of cultural heritage endowment on the economy is investigated via an empirical neoclassical growth model (Solow 1956) augmented with a cultural heritage variable (Throsby 1999). In our model, the impact of cultural heritage on economic growth takes place through the tourism demand channel. Thus, promoting cultural heritage assets makes them more

[1] Note that a recent Eurobarometer survey (European Union 2018) shows that the vast majority of European citizens think that cultural heritage is important to them personally (84%), as well as to their community (84%), region (87%), country (91%) and the EU as a whole (80%). Also, 79% of the responders agree (against 13% who disagree) that Europe's cultural heritage or cultural heritage-related activities create jobs in the EU.

attractive to visitors, giving rise to a greater demand for cultural tourism which generates more income and employment (Richards 2002, 2007). At the same time the process of promoting cultural heritage assets improves cultural and social capital which further boosts economic development and growth (Beugelsdijk and van Schaik 2005; Malecki 2012). Thus, cultural heritage assets create incomes, employment, revenues and wealth. The case of Greece (2000–2019) serves as an example for our empirical investigation. Cultural heritage has been recognized in the EU as a European advantage and an engine of growth, making this investigation more valuable. Our paper brings fresh ideas in many respects.

The first novelty is the choice of a cultural heritage variable incorporated in the empirical model that depicts the impact of cultural heritage on the economy. We define a cultural heritage variable, the cultural heritage (CH) index, which is a proxy of the relative importance of cultural tourism with respect to total tourism volume. The CH index is calculated as the ratio of visitors to historical monuments to the total number of tourists in a region. The number of visitors to historical monuments indicates the attractiveness and market value of cultural heritage assets, which may be due to the development of the number of open to public monuments (supply side effect) and/or the number of cultural visitors (demand side effect). Furthermore, the CH index is a dynamic measure that accounts for developing cultural heritage market value over time. Hence, the CH index captures cultural heritage's economic impact more efficiently than using a time-invariant proxy such as "the number of UNESCO's World Heritage Sites" used in most relevant empirical studies.

The second point of interest is that we investigate the impact of cultural heritage assets on the economy in broad terms, since we include in the analysis a significant number of important cultural heritage monuments and not only those of UNESCO's list, which again have been the focus of the majority of relevant empirical studies. To this end we have chosen to investigate the case of Greece, a country with an endowment of 156 open-to-public archaeological sites and 175 museums in 2019, including monuments of UNESCO's list, showing a strong regional allocation.[2]

Third, we explore the impact of cultural heritage on economic growth at regional level using panel estimators that account for cross-region heterogeneity and cross-sectional dependence. By doing so, we can consider various sources of heterogeneity among regions. Moreover, we examine the effect of cultural heritage on economic growth across conditional distribution, which is vital for policymaking as it provides insights into the effects at the extremes of the distribution. Neglecting distributional heterogeneity in the analysis may lead to erroneous results and inappropriate policy recommendations. Also, we employ a novel bootstrapping panel Granger non-causality approach that reduces cross-sectional dependence. This approach yields more detailed information on causal relationships, leading to more accurate policy implications.

The rest of the paper is organised as follows. Section 2 is the literature review. Section 3 briefly presents features of the Greek economy. Section 4 discusses the

[2] Note that in the Eurobarometer survey (European Union 2018) the citizens were asked if their home is nearby any historical monuments or heritage sites, the positive answers in Greece were 70% (along the top 1/3 EU countries) against 60% of the EU28 average.

methodology, data and variables used in the empirical analysis. Section 5 presents the empirical results, and Sect. 6 summarizes the analysis results and concludes the issue.

2 Literature review

Several researchers have empirically investigated the relationship between cultural heritage and economic growth. Most empirical studies use "the number of UNESCO's World Heritage Sites (WHS)" situated in a country/region as a proxy to capture the impact of cultural heritage assets on the economy.

This variable was initially introduced by Faria and León-Ledesma (2008) as a proxy for cultural capital stock to assess its impact on economic growth. The rationale is that this variable depicts all aspects of the cultural contribution of each nation to humankind. The idea is that this proxy captures the intensity of culture, where a country with a large stock of cultural heritage has a comparative advantage over others with a smaller cultural heritage. It also reflects comparative cultural advantage in individual attitudes and social institutions that become or influence universal values, beliefs and norms. Their analysis of 87 countries showed that a country with a higher cultural heritage share grows faster, a finding strongly supporting the hypothesis that cultural heritage has a positive and significant impact on economic growth (Faria and León-Ledesma (2022). Similarly, Saccone and Bertacchini (2011), using UNESCO's World Heritage Sites for a panel of 131 countries over the period 1978–2007, found that economic size and participation in the World Heritage system are positively related; and the promotion and preservation actions of cultural heritage may create development opportunities.

Many empirical studies on the relationship between cultural heritage and economic growth have a strong local dimension; also, they provide a comprehensive understanding of the multifaceted role of cultural heritage in economic growth and development. They emphasize that regions and cities may build competitiveness by leveraging their cultural heritage (Scott 2000; Bandarin et al. 2011; Licciardi and Amirtahmasebi 2012). Promoting localized cultural industries is considered necessary in generating opportunities for commercial initiatives, business expansion, and employment growth and providing increased incomes and widespread community benefits. Furthermore, developing the local economy through a higher cultural and social capital attracts creative people, making production more efficient via higher technology, innovation, learning and entrepreneurship (Beugelsdijk and van Schaik 2005; Beugelsdijk et al. 2006; Sasaki 2010; Malecki 2012). The development of cultural heritage and cultural environments also attract specific skilled individuals from other regions (Backman and Nilsson 2018). Furthermore, cultural heritage embodies the character of a specific area, thus highlighting the effort of local policymakers and territorial institutions to develop programs and policies in order to promote and preserve this heritage (Rodríguez-Pose 2013, 2020).

Several empirical studies support that tourism positively affects economic development, since a country/region with a significant cultural heritage stock has an advantage over others with a smaller endowment. When a transmission channel is

considered, it is usually related to tourism, since cultural heritage and tourism are considered inextricably linked (OECD 2008).

Yang et al. (2010) empirically address the impact of cultural heritage on tourism flows in China, thus implying an indirect impact of cultural heritage assets on economic development. The number of UNESCO's World Heritage Sites is used as a proxy depicting the economic impact of cultural heritage. Their results show that this variable significantly explains the number of international tourism arrivals. Also, Arezki et al. (2012) investigate whether tourism specialization is a viable strategy for development by estimating standard growth equations for a cross-section of 127 countries from 1980 to 2002. Their models are augmented with an instrument measuring tourism specialization; the number of UNESCO's World Heritage Sites per 100,000 inhabitants in 2002. Their results show that the presence of UNESCO's sites significantly fosters tourism activities.

Cuccia et al. (2016) explore the effects of cultural heritage in fostering tourism demand. They use a DEA model to investigate the role of UNESCO's World Heritage Sites in boosting tourism destinations' competitiveness. The empirical analysis is carried out for 21 Italian regions and autonomous provinces from 1995 to 2010. The results show that cultural and environmental endowment positively affects the performance of Italian tourism destinations; also the presence of UNESCO's Sites exerts opposite effects. Bacsi and Tóth (2019) investigate the relationship between the presence of unique World Heritage Sites for tourist attractions and international tourism performance. Their empirical analysis for 129 countries over the period 2014–2017 shows that cultural and natural world heritage sites are generally strong tourist attractions and can contribute to increased tourism. Škrabic et al. (2021) estimate the impact of various cultural indicators on tourism development in 27 EU member states over the period 2008–2018, using dynamic panel data analysis. Their results indicate that the number of UNESCO sites significantly positively affects international tourism receipts and employment.

Kostakis et al. (2020) empirically investigate the relationship between cultural heritage assets and economic growth at regional level in the case of Greece (1998–2016). They employ a neoclassical growth model, and the analysis is based on GMM dynamic panel data. The empirical results reveal a positive impact of cultural heritage assets demand -reflected in the number of monument visitors- on growth. The results also show an influence of other growth factors, such as physical and human capital, fertility and unemployment on growth. Also, Doulgeraki (2018) investigated the macroeconomic impact of cultural heritage -in terms of the number of visitors to monuments- and tourist demand -in terms of tourism arrivals- on economic growth in Greece over the period 1970–2015. She found a strong impact of cultural heritage and tourism demand on economic growth.

Panzera et al. (2021), empirically investigate the impact of tangible cultural heritage on the tourism attractiveness of European regions using a Bayesian multilevel gravity model. Their study covers locally and nationally defined monuments, museums, and several monuments on UNESCO's list. They find that UNESCO's sites are far more attractive than regional or national monuments that play a more limited role in international tourism. Panzera (2023) investigates the impact of cultural heritage and tourism attractiveness on local economic development. The empirical analysis

for 269 European regions in the mid-2010s was carried out by estimating a structural equation model with cultural heritage, tourism attractiveness and economic development. Her results show that cultural heritage attracts tourists and, in turn, this increased tourism demand positively affects local economies.

Besides overall tourism, cultural tourism is closely related to cultural heritage offering a specific identity to tourist destinations and visitors. Cultural tourism is a kind of tourism activity where the visitors' essential motivation is to learn, discover, experience, taste and enjoy the tangible and intangible cultural attractions/products in a tourist destination (Richards 2018). It directly and positively affects economic growth, since a country or region with a significant cultural heritage stock has an advantage over others with a smaller endowment (Sasaki 2010; Licciardi and Amirtahmasebi 2012). Cultural tourism has been recognized as one of the most crucial transmission channels of cultural heritage endowment on economic performance (Richards 2002, 2007; Lee and Chhabra 2015). It brings new and fresh resources to the cultural sector, spotting new entrepreneurial opportunities by boosting economic activity, incomes and employment (Hampton 2005; Alberti and Guisti 2012; UNWTO 2018). However, cultural tourism is not the only transmission channel that affects economic development. Ashworth (2013) presents several channels through which cultural heritage could boost economic development. As a commercial activity, as a location factor for other economic activities, as a contributor to environmental amenities and local identity, as a factor of place image promotion and branding (Pasquinelli et al. 2023) and as an element of neighbourhood regeneration. A recent study by Cerisola (2019) shows that cultural heritage in Italy indirectly affects regional development through artistic and scientific creativity.

A number of studies raise the sustainability issue of the cultural heritage-tourism relationship. In particular, Loulanski and Loulanski (2011) reviewed 483 studies and provided an interpretive synthesis of 15 critical factors for the sustainable integration of heritage and tourism. They show that tourism raises the economic and cultural value of heritage, but an increased economic value cannot compensate for losing other values in the longer term. They conclude that cultural heritage should be viewed as an irreplaceable form of capital (cultural, social, environmental and economic) wisely used, preserved, sustained and enhanced instead of being irretrievably consumed by tourism. Also, Nocca (2017) investigates cultural heritage's role in sustainable development by analysing the case of 40 cultural heritage conservation/regeneration projects, proposing a set of nine categories of multidimensional indicators. It is shown that in most cases, only the economic component is highlighted, leaving out the social and environmental dimensions. Furthermore, Romão and Neuts (2017) investigate the impact of tourism specialization to regional development, accounting for natural and cultural features, innovation capabilities and specialization patterns, for 252 European regions. They find the coexistence of different regional patterns of tourism dynamics leading to important spatial unbalances.

On the other hand, Dümcke and Gnedovsky (2013) provide evidence from several empirical studies, showing that generating knowledge and developing educational and innovative products is an indispensable feature of the heritage sector (smart growth). In addition, cultural heritage has a great potential for skills development and the generation of direct and indirect jobs, thus fostering social cohesion (inclusive growth). Finally, they support that cultural heritage contributes to sustainable

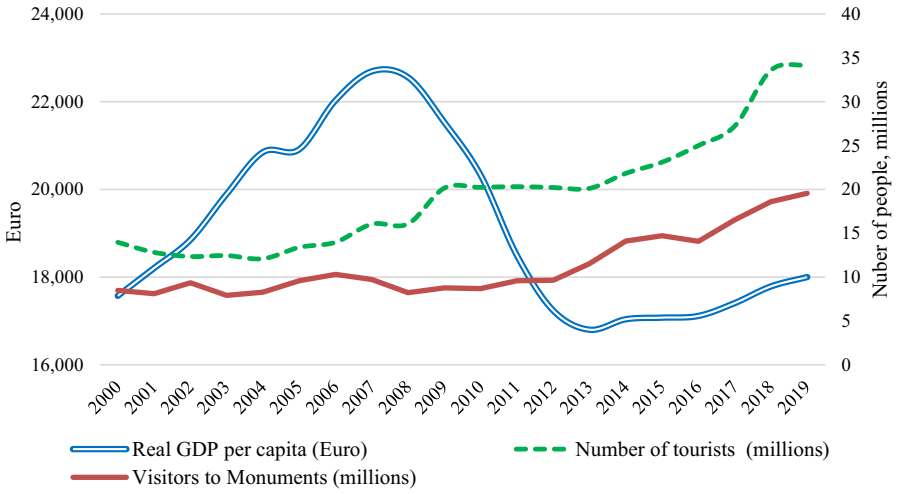

Fig. 1 Real GDP per capita (left axis); number of tourists and visitors to monuments (right axis), 2000–2019. *Sources*: Eurostat and ELSTAT (Hellenic Statistical Authority)

growth by merging modernity and tradition and raises the profile of places, making them more competitive. Finally, micro-approaches assess the economic impact of cultural heritage on the local economy (e.g. Bowitz and Ibenholt 2009) or the impact of specific cultural events (e.g. Srakar and Vecco 2017).

3 Features of the Greek economy

In the period under review (2000–2019), the Greek economy followed two different paths (Fig. 1). Over most of the 2000s, the economy achieved high average growth rates of around 4% per annum, well above those of the EU countries. However, after 2007 there was a rapid deterioration of the Greek economy's internal and external balances, which almost coincided with the beginning of the global financial crisis (2008). In 2009, the external imbalance and the public sector deficit rocketed to over 15% of GDP, while the public debt to GDP ratio increased to 127% from around 100% in the first half of the 2000s (OECD 2009).

In 2010, the government, to avoid default, was obliged to enforce a severe structural adjustment programme which would turn into a series of adjustment programmes (2010, 2012, 2015) mainly financed by the EU countries (European Commission 2018a; IMF 2019). Various governments that came to office were thus obliged to implement severe austerity measures for fiscal consolidation, the achievement of external balance and competitiveness improvement, including tax increases and cuts in wages, pensions and salaries. As a result, the economic activity underwent an unprecedented depression, losing around 25% of its output (2010–2017) (Fig. 1), while the rate of unemployment tripled to 28% relatively to previous periods. After 2017/8 the economy started recovering with annual rates of 2% by 2019, while the unemployment rate dropped gradually to 17% (OECD 2023).

Tourism has always been a priority sector in Greece related to the country's exceptional natural features, history and cultural heritage which are considered to be the catalyst in tourism development. Over the period 2000–2019 the number of international tourists more than doubled, from 13.8 to 34.2 million people (Fig. 1). In particular after the Athens Olympics (2004) and in conjunction with the adverse conditions in the tourist markets in the Eastern Mediterranean in the early 2010s,[3] tourism flows increased sharply. The industry enjoys easy finance and in recent years a more even expansion of tourism across regions is observed. However, the nature of Greek tourism greatly relies on ("sun and sea") mass tourism showing a strong seasonality. In the post Greek economic crisis period (2010), positive tourist developments were facilitated by tourist market reforms giving a boost to the struggling domestic demand (Bank of Greece 2019).

Owing to its long-standing history, a distinct feature of Greece is its significant cultural heritage endowment, such as historical monuments, archaeological sites and museums. The country's rich historical legacy is reflected in UNESCO's World Heritage List.[4] Over the period 2000–2019, the number of visitors to archaeological sites and museums more than doubled from 8.5 to 19.6 million people (Fig. 1).[5] This ascending trend, especially over the second half of the period, reflects an expansion in cultural tourism demand and is also due to an increased number of museums and publicly accessible archaeological sites, including the launching of the flagship Acropolis Museum (2009). Note that the number of accessible public monuments has doubled over the period under examination (2000: 168, 2004: 183, 2010: 254, 2015: 274, 2019: 332).[6]

The historical sites and museums are scattered across regions. However, the regional distribution of visitors is not uniform, depending on the characteristics of each monument, such as its historical importance, the convenience of visiting it, the attractiveness of the specific region, etc. About half of the regions, mainly those where important *UNESCO* monuments are situated, attract most visitors to historical sites and museums.[7] In particular, from 2000 to 2019 Attica attracted about 35% of total visitors to monuments in Greece and another *three* highly touristic regions (South Aegean, Crete and Peloponnesus) attracted around 15% of total visitors each. These top *three* regions are highly appreciated by about 80% of total visitors to monuments. They are followed by *three* regions (Central Macedonia, Central and Western Greece) with about 5% visitors each, while the attractiveness of the remaining

[3] Events such as the Arab Spring and the Syrian civil war (2011); also the crisis of Crimea and Ukraine (2014).

[4] For the list of monuments, see *UNESCO* (2018), https://whc.unesco.org/en/statesparties/gr.

[5] According to Richards (2007) the growth of cultural tourism is largely driven by increased overall tourism.

[6] See https://www.statistics.gr/en/statistics/-/publication/SCI21/- for the list of archaeological sites and museums in Greece.

[7] The *thirteen* NUTS II regions of Greece are Eastern Macedonia-Thrace (Anatoliki Makedonia-Thraki), Central Macedonia (Kentriki Makedonia), Western Macedonia (Dytiki Makedonia), Thessaly (Thessalia), Epirus (Ipeiros), Ionian Islands (Ionia Nisia), Western Greece (DytikiEllada), Central Greece (StereaEllada), Attica (Attiki), Peloponnesus (Peloponnisos), Northern Aegean (VoreioAigaio), Southern Aegean (NotioAigaio) and Crete (Kriti).

six regions (Eastern Macedonia-Thrace, Western Macedonia, Epirus, Ionian Islands, Thessaly and Northern Aegean) is lower but not negligible.

Regarding the value of Cultural Heritage index, defined as the ratio of the total number of visitors to monuments to the total number of tourists in Greece, it amounts to around 50% on average over the period 2000–2019. Therefore, besides the richness of historical monuments in Greece, it seems that, on average, less than half of the tourists visit historical monuments, since many tourists visit more than one monument.

The regional distribution of the cultural heritage index in Greece is shown in Fig. 2. Note that in *four* regions (Attica, Peloponnesus, Western and Central Greece) the index is well above the country's average (80–120%) and in another *two* regions (Southern Aegean, Crete) is close (60%) to the average. However, in the remaining *seven* regions the cultural heritage index is relatively low (15%), which means that the number of monument visitors in those regions can be increased substantially. Note that extensive overcrowding ("over-tourism") in regions, where world heritage sites are situated has not been so far noticed.

The relationship of real GDP per capita of the Greek regions and the cultural heritage index for the period 2000–2019 is shown in Fig. 3, where a positive correlation between the two variables is observed. Also, it is shown an uneven regional distribution, since in *six* regions the per capita income is around the country's average (16,771€) and the cultural heritage index is above 0.80, while the remaining *seven* lagging behind regions have a cultural heritage index of less than 0.20.

4 The model, data and methodology

4.1 The model

Economic theory and especially neoclassical models usually incorporate only strictly economic variables, such as capital and labour (e.g. Solow 1956). Following the discussion above, if the role of cultural heritage in economic performance is assumed away, there is a danger of a misleading solution (Gray 1996). Thus, an empirical model incorporating cultural and economic variables is superior to an explanation emphasizing one set of these variables. The point of departure of our empirical analysis is a modified neoclassical growth model that incorporates cultural factors as independent variables affecting economic growth. The empirical model is written as follows[8]:

$$\mathrm{GDP}_{i,t} = \beta_0 + \beta_1 \mathrm{PhysCap}_{i,t} + \beta_2 \mathrm{Unempl}_{i,t} + \beta_3 \mathrm{CultHer}_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where $i = 1, \ldots, 13$ denotes regions, $t = 2000, \ldots, 2019$ denotes time, β_i s are the estimated coefficients and $\varepsilon_{i,t}$ is the error term.

[8] In the econometric analysis all variables are expressed in natural logarithms to obtain elasticities. They are denoted by the prefix *ln*.

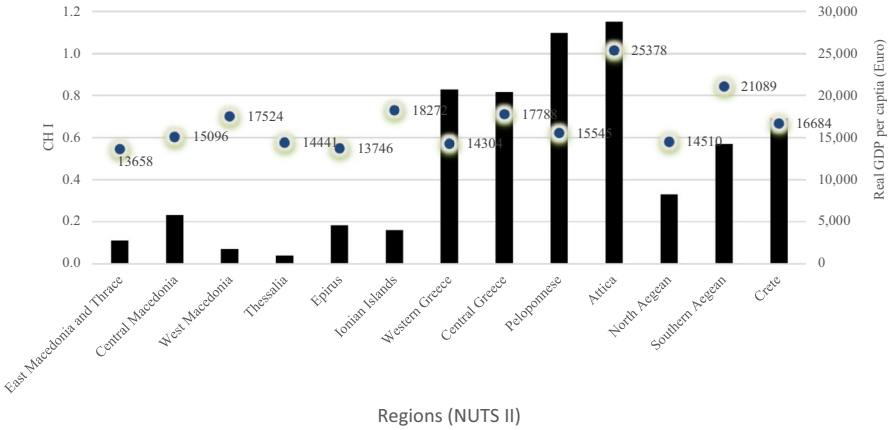

Fig. 2 Cultural Heritage index (columns-left axis) and real GDP per capita (dots-right axis), average 2000–2019. *Sources*: Eurostat and ELSTAT (Hellenic Statistical Authority)

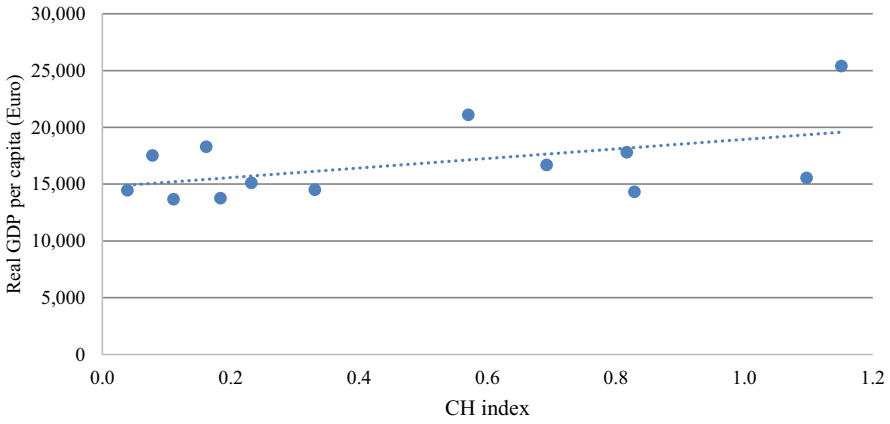

Fig. 3 Cultural Heritage index and real GDP per capita, average 2000–2019. *Sources*: Eurostat and ELSTAT (Hellenic Statistical Authority)

4.2 Data and variables

The dataset covers 13 Greek regions (NUTS II) over the period 2000–2019. Table 1 provides information on the variables used in the analysis. The data for constructing the variables is obtained from Eurostat and ELSTAT (Hellenic Statistical Authority).

The dependent variable $GDP_{i,t}$ represents the per capita real gross domestic product (in Euro). It is calculated as the ratio of real GDP (chain linked volume) to the average population of each year. The explanatory variables included in the empirical model are the following.

(i) Physical Capital

Table 1 Data description

Symbol	Variable	Unit (Source)	Expected sign
GDP	Real gross domestic product per capita	Euro in contant (2010) prices (Eurostat)	
PhysCap	Real gross fixed capital formation per capita	Euro in contant (2010) prices (Eurostat)	+
Unempl	Unemployment rate	Number of unemployed persons over total labour force (Eurostat)	–
CHindex	Cultural heritage index	Number of admissions to archaeological sites and museums (ELSTAT) as a ratio to total tourism arrivals (Eurostat)	+

$PhysCap_{i,t}$ indicates the per capita physical capital (in Euro). It is constructed by dividing gross fixed capital formation by the national deflator. According to the neoclassical model, gross fixed capital formation is an important growth factor that reflects investment in capital accumulation, technological innovation, and advancements that play a vital role in the growth process (Abreu 2019; Audretsch 2009; Acs and Audretsch 1988). At the same time, cross-sectional differences in economic performance can be associated with different investment rates (O'Mahony and de Boer 2002). In the case of Greece, several empirical studies have highlighted the role of physical capital on economic growth and found that physical capital exerts a strong positive impact on output (Fotopoulos and Spence 1998; Louri and Anagnostaki 1995; Liargovas and Repousis 2015).

(ii) Unemployment

$Unempl_{i,t}$ denotes the rate of unemployment for region *i*. It expresses the ratio of the total number of unemployed persons divided by the total labour force in the region. This variable is included in the model to capture an "Okun's law" type of growth-unemployment trade-off at regional level. An inverse impact of unemployment on economic growth is expected, highlighting that increased unemployment is related to lower output. Also, the unemployment variable in the relationship reflects the existence of an aggregate supply curve, and from an empirical perspective, the unemployment coefficient offers a tool for policymaking. Okun's Law (1962) is empirically verified at the regional level in Greece (Apergis and Rezitis 2003; Christopoulos 2004). Also, Lolos and Papapetrou (2012) empirically investigated the relationship between unemployment and real sector developments.

(iii) Cultural Heritage

The investigation of the impact of cultural heritage on economic activity is carried out through its relation to cultural tourism demand, on the grounds that cultural tourism is the most important transmission channel of cultural heritage endowment on economic performance (Richards 2002, 2007; Lee and Chhabra 2015). Cultural heritage affects economic growth through cultural tourism demand, boosting job creation and attracting investment and businesses. Preserving and promoting cultural heritage assets can attract tourists and generate income through spending (accommodation, food, and souvenirs) and create jobs in construction, hospitality and cultural management. In addition, the development of cultural heritage necessitates the enhancement of cultural and social capital (Beugelsdijk and van Schaik 2005; Malecki 2012), by attracting specific skills (Backman and Nilsson 2018) such as multilingual guides, archaeologists, professional managers and computer experts and by technological upgrading production and entrepreneurship. At the same time it is created an environment for the efficient operation of institutions and the formulation of innovative policies in order to boost and preserve cultural heritage (Rodríguez-Pose 2013), providing regions with a sense of place and identity.

The impact of cultural heritage endowment on the economy at regional (NUTS II) level is shown in the cultural heritage index, denoted by $CH\ index_{i,t}$. It is calculated as a ratio of the annual number of visits to archaeological sites and museums

obtained from ELSTAT over total annual tourism arrivals taken from Eurostat. We use tourism arrivals to indicate the volume of tourism flow, as this variable is widely used in the relevant literature (Katircioglu 2009; Lolos et al. 2021). By the same token, we use the number of visits to archaeological sites and museums to reflect the market value of tangible cultural heritage assets. It captures the attractiveness of cultural heritage assets and gives an account of the volume of cultural tourism.[9]

Thus, the CH index is a proxy of the relative importance of cultural heritage-led economic activity, i.e. cultural tourism, with respect to total tourism activity. It is a dynamic measure, incorporating demand and supply side effects of cultural heritage developments and is expected to affect income positively. Note that a positive impact of overall tourism on economic activity, the "tourism-led growth hypothesis" is empirically verified in the Greek case (Dritsakis 2004; Lolos et al. 2021).

Cultural heritage refers to cultural capital, both tangible and intangible, that has been inherited from previous generations. The tangible form includes museums, historical monuments, buildings, sites, cities or open public spaces, while intangible cultural phenomena include festivals, dances, rituals, traditional knowledge, etc. (Throsby 2012). Two different types of values can be derived from cultural heritage. The first is the *market (use) value* related to the revenue obtained from cultural heritage as a private good. Regarding monuments that tourists visit, the market value includes revenues from entrance tickets, economic benefits that tourists enjoy and revenues from the commercial exploitation of the monuments. The second is the *non-market (non-use) value*, related to the intangible religious, historical, social, aesthetic, emotional, or identity value accruing to those who experience the benefits of cultural heritage as a public good (Throsby 1999).

In our empirical analysis, only the tangible cultural heritage endowment is investigated. Intangible cultural heritage, such as handicrafts, gastronomy, festivals, concerts, oral traditions, and other cultural events, is considered to be as substantial. Still, its market value has not been accounted for due to lack of quantitative data.

4.3 Methodology

In this study, we employ panel cointegration analysis to investigate the association between gross domestic product, physical capital, unemployment rate, and cultural heritage index at a regional level. The eight-step analysis strategy regarding the econometric methodology is shown in Fig. 4.

[9] The empirical approach followed is very much determined by the existing data. The available regional statistical information for Greece does not allow investigating cultural heritage in more detail, by adding more explanatory variables in the model, as in the study of Tubadji et al. (2022) for Italy.

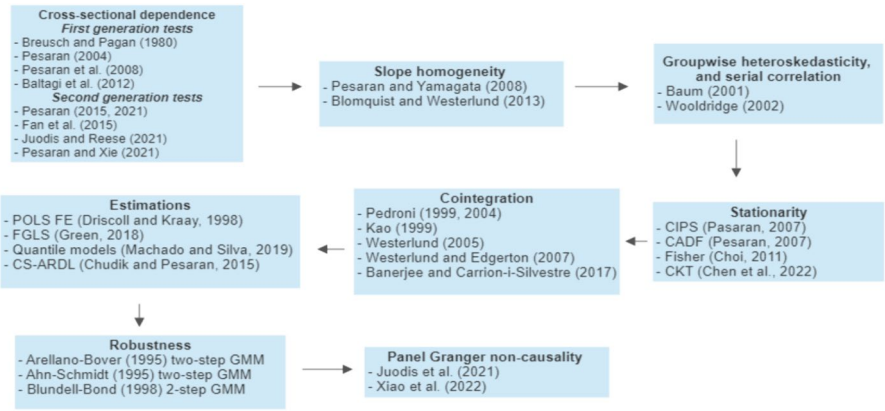

Fig. 4 Econometric methodology flow chart

5 Empirical results

Table 2 presents the summary statistics (before log transformations) for the dependent and independent variables utilized in the analysis. Real GDP and physical capital are expressed at per capita levels. Unemployment is a ratio, and the cultural heritage index measures the total number of admissions to monuments over the total number of tourist arrivals in each region.

As can be seen, the average real GDP per capita is around 17,000 Euros. The average real gross fixed capital formation per capita is around 3000 Euros, exhibiting a core/periphery regional distribution pattern. The unemployment rate ranges from 4.7 to 31.6%, highlighting the heterogeneous regional profile of the country. The cultural heritage index's average value of around 0.50 is close to the Member States' World Trade Organization (2018) estimation. This result indicates that around 50% of tourists visit at least one museum or archaeological site.

We now turn to the econometric analysis. Firstly, we should note that regions of the same country are supposed to be highly interlinked, and the possibility of cross-sectional dependence (CSD) must be considered (Kapetanios et al. 2011). We may have biased stationarity and cointegration analysis estimates if cross-sectional dependence is not addressed. To this end, we employ first and second-generation cross-sectional dependence tests. The tests used are shown in Table 3: the Pesaran (2004) CD_{2004}; the Pesaran et al., (2008) $adjustedCD_{LM}$; the Breusch-Pagan (1980) Lagrange Multiplier BP_{LM}; and the bias-corrected scaled LM (Baltagi et al. 2012) LM_{adj}. In addition, we use second-generation cross-sectional dependence tests, such as the Pesaran (2015) CD_{2015} test for weakly exogenous cross-section dependence in the large panel data econometrics combined with the Juodis-Reese (2022) CD_w; the Fan et al. (2015) CD_{w+}; and the Pesaran-Xie (2023) $CD*$ test.

According to the results, the null hypotheses of cross-sectional independence (Panel A) and weak cross-sectional dependence (Panel B) are highly rejected. Hence, the empirical findings affirm the presence of CSD within the panel time-series data.

Table 2 Summary statistics

Variables	Obs	Mean	SD	Min	Max	Skew	Kurt
GDP (Euro)	260	16,771	4098	11,028	31,309	1.05	4.21
PhysCap (Euro)	260	2990	4311	297	25,191	3.40	14.93
Unempl (rate)	260	15.37	6.86	4.70	31.60	0.59	2.13
CHindex (index)	251	0.498	0.422	0.004	1.756	0.84	2.77

Table 3 Results from the cross-section dependence tests

Variables	CD_{2004}	CD_{LM}	BP_{LM}	LM_{adj}
Panel A: First-generation cross-sectional dependence tests				
lnGDP	36.31***	100.72***	1336.09***	100.38***
lnPhysCap	36.89***	102.89***	1363.10***	102.55***
lnUnemp	35.92***	97.58***	1296.72***	97.23***
lnCHindex	12.62***	32.96***	489.65***	32.66***
Variables	CD_{2015}	CD_{w}	CD_{w+}	$CD*$
Panel B: Second-generation cross-sectional dependence tests				
lnGDP	36.31***	− 2.25**	318.43***	3.75***
lnPhysCap	36.89***	− 2.88***	322.88***	− 2.55**
lnUnemp	35.92***	− 2.47**	314.73***	− 1.18
lnCHindex	13.06***	− 2.35**	186.04***	− 0.54

All tests assume the null hypothesis of cross-section independence. *** and ** denote a 1% and 5% significance levels, respectively. Tests: CD_{2004}—Pesaran (2004); CD_{LM}—Pesaran et al. (2008); BP_{LM}—Breusch-Pagan (1980); LM_{adj}—Baltagiet al. (2012); CD_{2015}—Pesaran (2015, 2021); CD_{w+}—Juodis-Reese (2021); CD_{w}—Fan et al. (2015); $CD*$—Pesaran-Xie (2023)

This outcome signifies a level of interdependence among regions, suggesting that observations for distinct regions simultaneously may exhibit correlation or be influenced by common factors. Also, CSD implies that a positive or negative shock in one region can potentially affect another region.

After CSD, the slope homogeneity test checks whether heterogeneity among slope coefficients exists across regions. The slope homogeneity tests proposed by Pesaran and Yamagata (2008) and later updated by Blomquist and Westerlund (2013) are employed, following Bersvendsen and Ditzen (2020) approach, which allows for serial correlation, heteroscedasticity, and cross-sectional dependence, respectively. Under the null hypothesis, the slope coefficients are homogeneous across cross-sectional units. So, if the slope homogeneity hypothesis is rejected, model coefficients are heterogeneous, and estimators allowing for slope variation across regions should be employed. In addition, we check the possibility of groupwise heteroscedasticity (Wald statistic; Baum 2001) and cross-sectional correlation (Wooldridge test 2002) in the context of our series (Drukker 2003; Green 2000).

Table 4 provides the Delta (Δ) and Delta-adjusted (Δ_adj) approaches for static and dynamic models. The results of the slope homogeneity tests, conducted at a 1% significance level, reject the null hypothesis, indicating the heterogeneity of the slope coefficients. Also, groupwise heteroscedasticity and serial correlation are present in our series. This implies that the variance of the error term varies across different cross-sectional units, while the error terms for a particular unit seem to be correlated across periods. To account for this issue we use feasible generalized least squares (*FGLS*) approach (Bai et al. 2021).

Subsequently, we analyse the stationarity of the series by utilizing several unit root tests. Stationarity is pivotal, denoting the constancy of statistical properties like mean and variance over time. Non-stationary data can yield spurious outcomes and erroneous inferences. Additionally, stationary series lend themselves to more straight forward modelling and analysis. Models constructed on stationary data yield more precise parameter estimates and offer more dependable forecasts. It contributes to comprehending the dynamics of each unit throughout the observed period, facilitating the identification of long-term trends and enabling meaningful cross-unit comparisons.

If there is cross-sectional dependence, the second-generation panel unit root tests, such as Cross-sectional Augmented Dickey-Fuller (CADF) and Cross-Sectional IPS (CIPS) unit root tests developed by Pesaran (2007), must be specified.[10] Under the null hypothesis, variables are unit root processes. We also perform two additional panel unit root tests as a robustness check. First, the Chen et al. (2022) panel unit root test that allows for possible structural breaks in the series, like the financial crisis, is utilized. If the series are not stationary in levels, they can be co-integrated and a long-term relationship can be estimated, regardless of the existence of structural breaks. In our case, a bootstrap procedure calculates the critical tests and *p*-values, assuming that errors are non-normal, cross-sectionally dependent, and cross-sectionally heteroscedastic. The null hypothesis indicates that all series in the panel are not stationary. The alternative is that some or all of the series are stationary, with breaks in the deterministic specification. Secondly, the Fisher-type (Choi 2001) PP test taking CSD into account (*demean option*) is also employed.

The empirical results shown in Table 5 reveal that the dependent variable (lnGDP) contains a unit root but becomes stationary at first differences. The variable lnPhysCap is stationary in its level form I(0), while for the variables lnCHindex and lnUnempl, the results are mixed. However, we can see that all series are stationary at their differences.

We then proceed to cointegration analysis to ascertain the presence of any long-term relationships among the variables. We run the Pedroni (1999, 2004) approach that proposes a residual-based cointegration test for a cross-sectionally independent panel, the Kao (1999) test, which assumes homogeneity in the panels, and the Westerlund (2005) specification that mitigates the issues of optimal lag and bandwidth orders. However, these tests can generate biased estimates under cross-sectional dependence. So, we further apply the Westerlund and Edgerton (2007) and the

[10] The *xtcips* (Sangiácomo 2018) and *pescadf* (Lewandowski 2007) routines are applied in *Stata* software.

Table 4 Slope homogeneity, groupwise heteroscedasticity, and serial correlation tests

	Static model	Dynamic model
Slope homogeneity test		
Δ-statistic	5.047***	4.492*
Δ_{adl}-statistic	5.863***	5.473**
Groupwise heteroscedasticity test		
Modified Wald test	–	552.35***
Serial correlation test		
Wooldridge test	–	221.36***
	Static model	Dynamic model
Slope homogeneity test		
Δ-statistic	5.047***	4.492*
Δ_{adl}-statistic	5.863***	5.473**

The null hypothesis for the Δ-statistic and Δ_{adj}-statistic is slope homogeneity. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively. The null hypothesis for the modified Wald test is groupwise homoskedasticity. The null hypothesis for the Wooldridge test is non-serial correlation. The tests' serial correlation and robust heteroscedasticity versions follow Bersvendsen and Ditzen's (2020) approach that addresses cross-sectional dependence.

Banerjee and Carrion-i-Silvestre (2017) panel cointegration tests.[11] All tests except the LM bootstrapping (Westerlund and Edgerton 2007) have a common null hypothesis of no cointegration.[12]

According to the results shown in Table 6, cointegration analysis supports a long run association between the variables for all panels. This result implies a long-term relationship among the variables under consideration across different regions and over time. Alternatively, we can say that this finding suggests that a stable equilibrium relationship binds the variables together in the long run so that we can estimate long run regressions.

Once cointegration is confirmed, we investigate all model variables' long run and short run dynamics. Given the presence of CSD and endogeneity, simple OLS, GLS, FE, and RE models might produce unreliable estimates (Sarafidis and Robertson 2009). Thus, we follow pooled ordinary least squares with Driscoll-Kraay (1998) standard errors (*POLS-DK*) and fixed effects with Driscoll-Kraay standard errors (*FE-DK*) that address cross-sectional dependence. We also use feasible generalized least squares (*FGLS*) model to account for heteroscedasticity and cross-section serial correlation (Bai et al. 2021). The results are shown in Table 7. The following step is checking the long run and short run estimations through several specifications.

In line with recent empirical studies (O'Mahony and de Boer 2002; Abreu 2019), physical capital positively and significantly correlates with real economic growth,

[11] The Westerlund and Edgerton (2007) and Banerjee and Carrion-i-Silvestre (2017) routines are applied in *GAUSS* software.

[12] The *demean* option has been employed in all first-generation tests to mitigate cross-sectional dependence.

Table 5 Panel unit root tests

Variables	*CKT*	*CIPS*	*CADF*	*Fisher-PP*	Variables	*CKT*	*CIPS*	*CADF*	*Fisher-PP*
lnGDP	− 0.00	− 2.22	− 2.14	12.06	ΔlnGDP	− 0.03**	− 4. 18***	− 2.71***	135.31***
lnPhysCap	− 0.24*	− 3.83***	− 3.87***	64.79***	ΔlnPhysCap	− 1.34***	− 4.84***	− 4.34***	265.47***
lnUnemp	− 0.15	− 3.05***	− 3.03***	44.27**	ΔlnUnemp	− 1.01***	− 4.37***	− 3.87***	186.93***
lnCHindex	− 0.13	− 2.76*	− 0.59	28.07	ΔlnCHindex	− 2.12*	− 5.21***	− 6.61***	209.89***

The null hypothesis for all tests is non-stationarity: Unit root. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively. *CKT* represents the panel unit root tests allowing for unknown structural breaks, using the methodology developed by Chen et al. (2022). Δ denotes the first difference operator. Variables in level are tested with constant and trend. Variables in the first differences are tested with constant. West Macedonia -with missing data- is not included in the *lnCultHer* Pesaran *CIPS* test as this test requests balanced data. Z t-bar values are presented in Pesaran's *CADF* test. Fisher-type unit root test *Fisher-PP* (demean option) presents an inverse chi-squared *P* statistic that requires the number of panels to be finite.

Table 6 Cointegration analysis

Pedroni modified PP		Kao modified DF	Westerlund Variance ratio
First-generation cointegration tests			
3.434***		− 1.479*	3.024***
Westerlund-Edgerton	Banerjee and Carrion-i-Silvestre (Lags 0)	Banerjee and Carrion-i-Silvestre (Lags 1)	Banerjee and Carrion-i-Silvestre (Lags 2)
Second-generation cointegration tests			
3.824	− 2.790	− 3.287**	− 3.110**

***, **, and * denote 1%, 5%, and 10% significance levels, respectively. Modified Pedroni and modified Dickey-Fuller statistics are presented for Pedroni (1999, 2004) and Kao (1999) tests. The variance ratio is presented for the Westerlund (2005) test. Westerlund and Edgerton (2007). The null hypothesis of the LM bootstrapping (number of bootstrap replications = 1000) test refers to cointegration. Critical value at 5% and 10% with trend is − 2.92 and − 2.82 for the Banerjee and Carrion-i-Silvestre (2017) cointegration tests. Cross-sections averages are also included in this cointegration.

Table 7 Long run models

Variables	Benchmark	*POLS-DK*	*FE-DK*	*FGLS*
lnPhysCap	0.111***	0.100***	0.207***	0.133***
	(0.007)	(0.006)	(0.020)	(0.012)
lnUnemp	− 0.197***	− 0.197***	− 0.113***	− 0.126***
	(0.022)	(0.025)	(0.031)	(0.014)
lnCHindex	–	0.037***	0.035**	0.019**
		(0.006)	(0.013)	(0.008)
Constant	9.390***	9.512***	8.482***	9.023***
	(0.090)	(0.097)	(0.217)	(0.117)
Observations	251	251	251	251
R-squared	0.467	0.507	0.859	-
Number of groups	13	13	13	13

Dependent variable: *lnGDP*

***, **, and * denote 1%, 5%, and 10% significance levels, respectively. Standard errors are presented in parentheses. *POLS-DK* pooled ordinary least squares with Driscoll-Kraay standard errors. *FE-DK* fixed effects with Driscoll-Kraay standard errors. *FGLS* feasible generalized least squares.

with an average (across models) value coefficient of 0.138. It implies that an increase of 1% in per head physical capital can boost economic growth by 0.14%. The importance of private and public investment is borne out by our results, given the crucial role the European Structural Funds play in infrastructure investment (Kachagia and Kyriazi 2021). The unemployment rate affects economic growth negatively, with an average value of − 0.158. Our findings indicate that a 1% increase in the unemployment rate is associated with a 0.16% drop in economic growth. This result supports the presence of an unemployment-income trade-off, aligning with previous studies for Greece, such as Christopoulos (2004) and Lolos and Papapetrou (2012).

Similarly to the impact of physical capital, our results reveal a long-term relationship between the Cultural Heritage index and economic growth. More specifically, a 1% increase in the Cultural Heritage index is associated with a 0.03% improvement in regional economic growth. Thus, there is empirical validation of a cultural heritage-led growth hypothesis, as the cultural heritage index (serving as a proxy variable for cultural tourism) exhibits a positive and statistically significant influence on regional income across all models. This finding aligns with previous research for China (Yang et al. 2010), Greece (Doulgeraki 2018; Kostakis et al. 2020) and European regions (Panzera 2023).

It should be noted that our analysis incorporates, by definition, only the effect of tangible cultural heritage assets. Intangible cultural events are not accounted for because of the non-availability of data. However, we know that many established events (e.g., the Athens and Epidaurus Festival, Patras Festival, Sani Festival, Philippi Festival) take place in the summer period in Greece, along with a significant number of ad hoc smaller-scale cultural events (local theatre performances, concerts, dancing festivals, exhibitions, religious fests, cine festivals, etc.) especially in the periphery.[13] Unfortunately, we do not have sufficient knowledge of the attention these events draw, but it might not be far from reality if we assume that the impact of the demand for intangible cultural events on the economy is comparable to that of tangible cultural heritage. Thus, we have good reasons to infer that the actual magnitude of the total effect of cultural heritage on income may well be about twice the estimated one. The estimations shown in Table 7 are robust to cross-sectional dependence, groupwise heteroscedasticity and serial correlation.

Furthermore, we investigate the relationship between the variables across the outcome variable's conditional distribution because we believe cultural heritage disparities may differ at various distribution points. To this end, we employ the novel approach of method of moments quantile regression (MMQR) developed by Machado and Silva (2019) that estimates quantile regressions with fixed effects at selected points of the conditional regional real GDP per capita distribution. This approach also allows valid conditional means estimations, while providing information on how the independent variables affect the entire conditional distribution (Hondroyiannis et al. 2022). This method accounts for cross-sectional dependence and slope heterogeneity. Table 8 presents the quantile regression estimates in nine deciles (*Q-0.1* to *Q-0.9*, columns 2–10).

Empirical results (Table 8) show a substantial positive association between physical capital per head (lnPhysCap) and real per capita income (lnGDP) along the conditional real regional per capita income distribution. The coefficients of physical capital are positive and statistically significant at all percentiles, suggesting that physical capital is a strong growth driver for all regions, irrespectively of the conditional distribution of real GDP. Concerning the labour market indicator, results show a strong negative association between unemployment (lnUnempl) and real income

[13] Note that according to the Eurobarometer survey (European Union 2018), in the question to European citizens about the existence of intangible assets nearby their home (traditional events or festivals), the positive answers in Greece were 58% (along with Cyprus and Portugal) against 37% of the EU28 average.

per capita. The effect is relatively more pronounced at the higher tails of the conditional income distribution. That is the impact of unemployment is greater in high-income regions.

Finally, the coefficients of the Cultural Heritage index (lnCHindex) are positive and statistically significant across percentiles, except for the two upper tails (*Q-0.8 and Q-0.9*). This finding implies that cultural heritage assets, as reflected in cultural tourism, significantly affect economic growth with a greater effect in regions with lower income levels. Essentially, this result indicates that cultural heritage assets have the potential to stimulate higher growth in lower and middle-income level regions, which are also those with lower attractiveness of cultural tourism (see also Fig. 3). This is an important finding, since policy actions to promote cultural heritage assets are more effective for lagging behind regions.

For the accuracy of the static estimations, several dynamic models that address endogeneity issues, such as GMM and IV estimators,[14] are also employed. We should instrument the potential endogenous variables in dynamic panel estimations that are more capable than static models in accounting for heterogeneity. This is primarily achieved by employing the lagged dependent variable and appropriate lags as instruments for the variables. So, we have incorporated a lagged dependent variable to model regional income, given its high correlation over time and tendency to change in incremental amounts. Including the lagged dependent variable captures the speed of adjustment of per capita income and delineates the independent variables' long-term impact. More specifically, we employ several system GMM dynamic models, including the Blundell and Bond (1998), the Arellano and Bover (1995), and the Ahn and Schmidt (1995) estimators with predetermined covariates and curtailed instruments as proposed by Kripfganz (2019). All models and parameters based on GMM and IV estimators are shown in Table 9. As can be seen, dynamic GMM and IV estimators confirm previous findings.

Dependent variable: lnGDP to be similar with the rest of thetables

Subsequently, we employ the recently heterogeneous panel data model CS-ARDL approach (Chudik and Pesaran 2015) proposed by Ditzen (2021). This approach estimates both short run and long run coefficients with a mixed order of integration, tackling cross-sectional dependence (CSD) and endogeneity concerns through unit-specific autoregressive distributed lag (ARDL) specifications (Chudik et al. 2016). Moreover, CS-ARDL mitigates serial correlation, misspecification bias, and common correlation issues. Table 10 presents the empirical results.

According to the results of the CS-ARDL estimator, physical capital and cultural tourism contribution improve economic growth in the long run, while unemployment drops real income. Specifically, a 1% rise in physical capital per head could increase regional economic growth by 0.19%. Similarly, a 1% increase in the cultural heritage index may lead to higher economic growth by 0.13%. Note that estimating a second-generation approach (CS-ARDL) significantly improves the results. In our case, this approach gives cultural heritage assets a higher impact. Regarding unemployment, our results show that a drop in the unemployment rate by 1% could

[14] The *xtabond2* (Roodman 2009) and *xtdpdgmm* (Kripfganz 2019) routines are applied in *Stata* software.

Table 8 Quantile regression with fixed effects

Variables	*Q-0.1*	*Q-0.2*	*Q-0.3*	*Q-0.4*	*Q-0.5*	*Q-0.6*	*Q-0.7*	*Q-0.8*	*Q-0.9*
lnPhysCap	0.219***	0.216***	0.212***	0.210***	0.207***	0.205***	0.202***	0.199***	0.196***
	(0.039)	(0.024)	(0.024)	(0.020)	(0.018)	(0.019)	(0.021)	(0.025)	(0.031)
lnUnempl	− 0.075*	− 0.086**	− 0.097***	− 0.106***	− 0.115***	− 0.121***	− 0.130**	− 0.138***	− 0.148***
	(0.043)	(0.034)	(0.027)	(0.023)	(0.021)	(0.032)	(0.024)	(0.028)	(0.035)
lnCHindex	0.046*	0.042**	0.039**	0.037***	0.034***	0.032**	0.030**	0.027	0.025
	(0.026)	(0.021)	(0.016)	(0.014)	(0.012)	(0.013)	(0.014)	(0.017)	(0.021)

Dependent variable: *lnGDP*

***, **, and * denote 1%, 5%, and 10% significance levels, respectively. Standard errors are presented in parentheses. *Q* denotes quantile.

Table 9 Blundell-Bond (BB), Arellano-Bover (AB), and Ahn-Schmidt (AS) two-step GMM results

Variables	Blundell-Bond GMM	Arellano-Bover GMM	Ahn-Schmidt GMM
Lag of lnGDP	0.467***	0.537***	0.444***
	(0.044)	(0.074)	(0.087)
lnPhysCap	0.081***	0.144***	0.114***
	(0.020)	(0.024)	(0.025)
lnUnempl	− 0.096***	− 0.050**	− 0.075**
	(0.019)	(0.021)	(0.021)
lnCHindex	0.026***	0.054***	0.034***
	(0.009)	(0.013)	(0.010)
Constant	6.023**	− 1.902	4.758***
	(0.430)	(2.718)	(0.761)
Time effect	Yes	Yes	Yes
Observations	239	239	239
Number of regions	13	13	13

Dependent variable: *lnGDP*

***, **, and * denote 1%, 5%, and 10% significance levels, respectively. Numbers in parentheses denote robust and WC-robust standard errors, respectively

increase economic growth by 0.15%. Also, the short run effects of all variables are lower than in the long run. Finally, the results show that the error correction term is negative, less than one(-0.798), indicating that any short run imbalances return to equilibrium in around five quarters.

Finally, our study provides new empirical evidence on the causal linkage among economic growth, physical capital, unemployment rate and cultural heritage index. It is important to note that Granger causality identifies whether past values of one variable help predict another variable. We believe exploring relationships between physical capital, labour and cultural heritage variables, and economic growth is important. Also, Granger causality tests can guide model specification by helping researchers identify which variables should be included in a model to improve its forecasting performance.

Thus, a novel recently developed panel, the Granger non-causality approach, proposed by Juodis et al. (2021) and Xiao et al. (2023), is used. We follow the bootstrapping method to reduce cross-sectional dependence, and the heteroscedasticity proposed provides more detailed information about causal linkage. Table 11 reports the empirical outcomes of the bi-directional Granger association among the variables panel.

Granger-causal linkages indicate a significant bi-directional relationship between the unemployment rate and economic growth. Specifically, the unemployment rate negatively affects regional GDP (− 0.186), and economic growth adversely affects the unemployment rate (− 0.759). On the contrary, a one-way Granger causality runs from physical capital and Cultural Heritage index to regional economic growth. In particular, the results show that physical capital increases real GDP per capita in

Table 10 CS-ARDL results

	Coefficient	z-statistic	*p*-value
Panel A: Long run			
lnPhysCap	0.188***	4.88	0.000
lnUnempl	− 0.152***	− 4.21	0.000
lnCHindex	0.129***	3.30	0.000
Panel B: short run			
D.lnPhysCap	0.109***	4.98	0.000
LD.lnPhysCap	0.027*	1.95	0.052
D.lnUnempl	− 0.050*	− 1.90	0.057
LD.lnUnempl	− 0.060**	− 2.06	0.039
D.lnCHindex	0.020	0.89	0.384
LD.lnCHindex	0.076***	4.48	0.000
Trend	− 0.002**	− 2.20	0.028
ECM_{t-1}	− 0.798***	− 8.96	0.000

Dependent variable: *lnGDP*

***, **, and * denote 1%, 5%, and 10% significance levels, respectively. The cross-sectional average of the dependent variable is added to the equation of the *CS-ARDL* model. *D* denotes the first differences, and *LD* denotes the lag of the first differences. ECM is the error correction model.

all Greek regions (0.211). Cultural tourism seems to significantly cause economic growth at regional level (0.130).

6 Conclusions and policy implications

This paper investigates the role of cultural heritage in determining economic activity by estimating a neoclassical empirical growth model augmented with a cultural heritage variable. The empirical model also accounts for other growth-related factors, such as physical capital, and unemployment. The case of Greece, a country with significant cultural heritage assets, is investigated over the period 2000–2019. The analysis is carried out at regional level, since cultural heritage assets have a strong local dimension.

Empirical results confirm that cultural heritage assets have a substantial impact on economic growth. Physical capital also has a substantial positive effect on income, while the impact of unemployment is negative. In addition, the quantile analysis shows that cultural heritage is more important in lagging behind regions that also attract lower numbers of cultural tourism. Finally, our results show the existence of a one-way causality from cultural heritage and physical capital to economic growth, while there is a two-way causality between the unemployment rate and income growth.

Given the empirical evidence of this study, several recommendations and policy guidelines can emerge to stimulate economic growth. In particular, our results call for formulating a coherent set of sustainable policy actions for promoting, preserving

Table 11 Panel Granger non-causality test

Null hypothesis	HPJ Wald-Stat	HPJ *p*-value	BIC	Coefficient	Stand. Errors	*p*-value
lnPhysCap does not Granger-cause lnGDP	19.316***	0.000	− 1314.94	0.211	0.048	0.000
lnGDP does not Granger-cause lnPhysCap	0.1475	0.675	− 740.46	0.238	0.569	0.675
lnUnemp does not Granger-cause lnGDP	51.874***	0.000	− 1311.56	− 0.186	0.026	0.000
lnUnemp does not Granger-cause lnGDP	40.968***	0.000	− 776.50 (lags 2)	− 3.267 (lag 1) 2.508 (lag 2)	0.555 0.392	0.000 0.000
lnCHindex does not Granger-cause lnGDP	19.267***	0.000	− 1302.75	0.130	0.030	0.000
lnGDP does not Granger-cause lnCHindex	0.010	0.919	− 654.35	0.023	0.227	0.919

*** denotes 1% significance level. Bootstrap Variances for the HPJ test is applied

and developing cultural heritage with priority to regions with less visited historical monuments, which also happen to be the lagging behind regions. The success of these policies will lead to regional convergence.

These actions involve promoting monuments by disseminating information (tourist guides, leaflets), and highlighting local myths, legends and human presence over the centuries (habitation, land exploitation, art and industrial activities, food production and nutrition). They should also be carried out using information and communication technologies (creation of digital environments, websites, computer apps and videos, participation in social media, online information, digital presentation of collections, e-tickets etc.).The design and implementation of these actions will enhance regional social and cultural capital, by requiring specific and high quality skills (multilingual guides, historians, archaeologists, professional managers, computer experts, etc.) and upgrading traditional professions and businesses. Thus, a virtuous circle of promotion of cultural heritage, growth and development is introduced. A rich cultural heritage can position a region as an attractive location for businesses and entrepreneurs, as it can offer a unique environment and a pool of social capital to boost regional competiveness, incomes and wealth.

In addition, tourist policies, by shifting the emphasis from "Sea and Sun" towards "Sea, Sun and Culture" destinations, that is boosting cultural tourism, will increase the inflow of tourism to less visited monuments and regions by awarding them a local identity that will be further enhanced if connected to gastronomy and quality. These initiatives would expand the tourist period, boost employment and incomes and launch new investment, thus enhancing regional competitiveness, productive capacity and well-being. It goes without saying that cultural heritage must be viewed as an irreplaceable form of capital that must be wisely used, preserved, sustained and enhanced and not irretrievably consumed by over-tourism.

Reforms of public institutions are also required, especially in the operational framework of Greek public authorities that are responsible for all aspects of cultural heritage. The aforementioned actions will be fulfilled more efficiently if there is dear collaboration of local authorities with private institutions, along with decentralization of policy making. The public authorities should keep their supervisory role but the design and implementation of cultural heritage policies will be greatly facilitated by public–private partnership initiatives. Furthermore, in order to activate the important synergies among cultural heritage, tourism and gastronomy that enhance cultural capital, there should be an interactive cohabitation of private institutions and public authorities involved.

Note finally, that according to our empirical results, economic growth will be greatly benefited if policies are also pursued by boosting physical capital and combating unemployment. There is ample room for such actions given the availability of EU financing through the European Structural Funds and the NextGenerationEU.

Nevertheless, this study is subject to limitations mainly relating to the availability of quantitative information. In particular, our empirical analysis covers only tangible cultural heritage as quantitative data on intangible cultural heritage (handicrafts, festivals, concerts, traditions, gastronomy, etc.) is missing. We believe the volume of intangible cultural heritage is quite important, perhaps as important as the tangible

counterpart. Thus, data construction describing the demand created by intangible cultural heritage is necessary. Also, to better understand the multifaceted role of cultural heritage in economic growth and development, more detailed social indicators should be produced to quantify social and cultural capital. In addition, quantitative data at local level, e.g. at NUTS III level, will definitely enrich the analysis.

Author contributions Both authors contributed equally.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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