Heritage tourism and regional growth: New insights and implications from spatial analysis

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Abstract

This study applies the theory of new economic geography to investigate the impact of heritage tourism on regional economic growth. We develop a novel theoretical framework and analyse British regional data using a spatial Durbin model with an instrumental variable approach to capture economic spillovers and tourism-related agglomeration. We also examine how different types of heritage influence regional growth. The findings indicate that both visits to heritage attractions and visits to attractions overall have statistically significant direct and total effects on regional economic growth, and provide evidence on the underlying mechanisms. The type of heritage attraction also matters. Museums and Art Galleries generate positive spillovers to neighbouring regions, while Historic Properties mainly produce local effects. Positive spatial growth dependence also persists. The results are robust to alternative spatial weight matrices and to controls for attraction distribution. These results have important implications for the management of heritage resources and for the design of policies to promote tourism-led regional growth.

Keywords

Tourism-led regional economic growth, direct and indirect effects, heritage tourism, heritage attractions, IV spatial Durbin analysis.

1. Introduction

The economic impact and growing appeal of heritage tourism are widely acknowledged. Heritage sites attract tourists, leading to economic benefits for destinations and tourism providers through multiplier effects (OECD, 2008). Heritage tourists have long been recognised as a lucrative market for many destinations, as they tend to spend more time and money there (OECD, 2008; Pompili et al., 2019; Timothy, 2018). The importance of heritage tourism has increased as tourists increasingly seek meaningful tourism experiences (Cheah et al., 2023; Timothy, 2020).

However, although heritage tourism can generate various indirect effects, these effects have not yet been thoroughly examined (Timothy, 2018). There is still much to learn about the theory supporting the idea that tourism can lead to regional economic growth (Calero and Turner, 2020). There is also an increased need to collect and learn from empirical evidence on the role of heritage tourism, as contextual differences across destinations may affect its impact on regional growth (Timothy, 2020).

Furthermore, heritage tourism has unique features and priorities, complicating its use as a vehicle for economic growth and development. According to Garrod and Fyall (2000), policymakers prioritise preserving heritage sites, with sales and revenue as secondary concerns in management decisions. However, the tensions among heritage preservation, commercialisation, and authenticity persist and are well-documented in the tourism literature (Timothy, 2018). Hence, despite its economic potential, using heritage sites to attract more tourists may not be the primary goal in strategic tourism policy planning.

This study aims to enhance understanding of heritage tourism in promoting regional economic growth, assisting destination management organisations (DMOs) in developing sustainable tourism and economic policies that maximise shared benefits. To achieve this, we adopt the New Economic Geography theory (NEG) to explore spatial agglomeration (Krugman, 1991 and 1998). The NEG acknowledges natural spatial clusters through a dynamic process in which market potential influences agglomeration and neighbouring regions. In tourism economics, once a destination is established, it can sustain itself through circular causation. Over time, initial location advantages become less important than agglomeration benefits. The NEG provides a new perspective to explore tourism-led economic growth. In line with this, we develop an empirically friendly regional economic growth model that captures economic and tourism-related agglomerations, drawing on past tourism studies (Faber and Gaubert, 2019; Li et al., 2016) and regional economics studies (Fingleton, 2001; Fischer, 2011; Lopez-Bazo et al., 2004). We then derive our empirical model accordingly and use the Nomenclature of Territorial Units for Statistics level 3 (NUTS3) British data to test the impacts of visits to heritage attractions and visits to attractions overall on regional growth.

We selected the UK for three reasons. First, studies on tourism-led economic growth have mainly focused on low-income and emerging markets over the past three decades, driven by globalisation, with notable exceptions such as Italy, Greece, Portugal, and Spain (Brida et al., 2016; Pulido-Fernandez and Cardenas-Garcia, 2021). Cold destinations like the UK have become less popular, despite tourism's contributions to GDP and job creation in service economies. An urgent need exists for knowledge transfer from new evidence. Second, a North-South divide persists in the UK (Gardiner et al., 2013), making it one of the most regionally unbalanced countries in Europe (McCann, 2020; Morrissey, 2020). Globalisation reshaped the economy, leaving post-industrial areas behind. The pandemic worsened disparities from high costs and digital poverty. Our findings can guide tourism specialisation and local priorities to reduce economic divides in the UK and similar nations. Third, UK public spending has declined since the 2008/09 financial crisis, with further cuts post-pandemic to manage national debt, affecting DMOs in tourism. Decreased funding has complicated a previously straightforward system (Coles et al., 2014). Assessing regional tourism's impact on economic performance is vital for enhancing resilience in the post-pandemic era for the UK and other European nations facing funding cuts.

Our study contributes to the literature in two main ways: (1) it implements and empirically tests the NEG in tourism-led economic growth hypothesis considering both tourism-related agglomeration and economic growth dependence, and (2) it explores whether the effect of visits to heritage attractions on regional growth varies depending on the type of heritage attraction.

To be more specific, we develop a simple, innovation-driven regional growth model for a small open economy that links tourism-related agglomeration to regional economic concentration through knowledge spillovers, within the NEG framework. Regional growth arises from information exchange and capital accumulation. Regional productivity depends on local labour productivity, tourists as "trading partners", and neighbouring regions through spatial spillovers. The model highlights the tension between diminishing returns of capital and agglomeration effects, yielding testable predictions that connect tourism specialisation, knowledge diffusion, and the geography of productivity growth.

Our empirical strategy follows the theoretical model and uses a unique British regional dataset combining attraction-level tourism surveys with NUTS3 economic data. We estimate a spatial Durbin model (SDM) with two-stage least squares (2SLS), instrumenting the spatial lags of regional growth and tourism with different external instruments. Unlike conventional maximum-likelihood (ML) estimation, our IV approach addresses multiple endogeneity concerns before fitting the SDM. For robustness, we also use a two-step generalised method of moments (GMM) estimator following the same identification logic. To the best of our knowledge, this empirical strategy offers a novel approach in tourism research that highlights the value of pairing a clear theoretical framework with rigorous econometric modelling.

We find that both visits to heritage attractions and attractions overall directly promote regional growth, with agglomeration generating additional positive total effects. The magnitude of these effects is economically meaningful. The type of heritage also matters. Museums and Art Galleries create spillovers that benefit neighbouring regions, while Historic Properties primarily generate local effects. Positive spatial growth dependence further persists. Our results are robust across different specifications and after accounting for the distribution of attractions. In line with the NEG, our results suggest that visit-based tourism-related activity not only fosters local growth but also generates wider benefits through spatial spillovers and agglomeration dynamics. These findings provide evidence on the regional economic impacts of visits to heritage attractions and offer implications for professionals and policymakers in promoting heritage packages to stimulate regional growth.

The remainder of the study is structured as follows. Section 2 reviews the literature and derives the theoretical framework. Section 3 outlines the econometric modelling and data analysis strategy. Section 4 reports estimation results and robustness checks. Finally, Section 5 concludes by discussing the theoretical, practical, and policy implications.

2. Literature Review and Theoretical Framework

2.1 Heritage attractions and visitor demand

Heritage attractions, especially UNESCO World Heritage sites, are key in destination choice (Bertacchini et al., 2024; Yang et al., 2019). Countries deploy attractions to enhance competitiveness, particularly larger nations (Dwyer and Kim, 2003). Yet evidence on their demand effects is mixed.

Cuccia and Cellini (2007) show that in Scicli (Sicily, Italy), lodging options and season, rather than UNESCO status, mainly determine tourist satisfaction. Huang et al. (2012) find no significant boost from UNESCO sites in Macau, only a minor short-run effect. By contrast, Panzera et al. (2021) report a positive correlation between UNESCO World

Heritage sites and inbound European tourists: international visitors travel long distances to these sites, whereas regional and national designations matter less.

Other studies emphasise spending and competition. Pompili et al. (2019) find that affluent heritage tourists substantially raise inbound tourism expenditure in Italy, while cultural attractions in neighbouring regions depress local spending, signalling regional competition. Bernini et al. (2017) show that the number of cultural, historical, and artistic sites has a small positive effect on domestic tourism in Italy and a weak negative effect on outbound tourism limited to the North. Bertacchini et al. (2024) find that UNESCO designation significantly increases tourist arrivals and overnight stays in Italian municipalities.

Overall, the ability of heritage attractions to stimulate demand and hence growth depends on destination features (season, weather, amenities) and heritage attributes (UNESCO status, proximity to other sites, spillovers). These factors shape the composition of visitors and their spending, highlighting the importance of evaluating these effects in context. A meta-analysis of 344 estimates from 43 studies (Yang et al., 2019) supports this view and shows that time period, data, measurement, and using robust standard errors materially affect results.

2.2 Heritage tourism spillovers and economic impacts

Heritage tourism can generate multipliers on both demand and supply (OECD, 2008; Timothy, 2018). On the demand side, it fosters understanding of cultural differences, supporting globalisation and growth, and often raises education levels, which further promotes development. In advanced economies, it is an important source of income because heritage tourists typically have higher socioeconomic profiles and spend more time and money (OECD, 2008; Pompili et al., 2019). The number of travellers for heritage and cultural reasons continues to rise as visitors seek more meaningful experiences (Cheah et al., 2023; Timothy, 2020).

On the supply side, open heritage sites enhance destination appeal and competitiveness (Crouch and Ritchie, 1999; Dwyer and Kim, 2003; Timothy, 2018). They stimulate cultural and creative industries, upgrade quality and pricing power, and revitalise established or undifferentiated destinations. Operators curate cultural/heritage packages that co-create value with other sectors (Sigala, 2019), generating indirect effects via tourism industries (accommodation, hospitality, retail) and synergies with the performing arts, food production, and heritage gastronomy.

Geography also matters. Heritage sites can pull visitors to nearby attractions, lifting demand, spending, and jobs (Panzera et al., 2021; Pompili et al., 2019; Yang et al., 2019). Such linkages foster spatial agglomeration as heritage assets become strategic resources that raise demand, strengthen competitiveness, and support economic growth.

2.3 New Economic Geography theory (NEG) and tourism-related agglomeration

The NEG explains the uneven spatial distribution of economic activity by modelling the interdependence of industries and locations through forward and backward linkages (Krugman, 1998). In a general equilibrium setting, spatial structure emerges from the "invisible hand", meaning that the joint distribution of labour, firms, demand, and supply generates agglomeration (Krugman, 1991). Firms and workers choose locations to maximise profits and earnings; knowledge sharing raises productivity, while concentration lowers transport and coordination costs.

Agglomeration reflects a balance between centripetal and centrifugal forces (Krugman, 1991). Centripetal forces expand market size via scale economies and cheaper local supply chains, deepen labour markets (reducing search and vacancy costs), and create information spillovers with increasing returns. Centrifugal forces arise from immobile factors (land, resources, and some labour), higher land rents, pollution, and congestion. Market size effects reinforce concentration in mobile factors while neglecting immobile ones (Krugman, 1998), helping explain hotspots (urban/coastal) and coldspots (rural/landlocked).

Applied to tourism, NEG complements traditional tourism geography. Tourists cluster where endowments (natural scenery, cultural heritage), accessibility (distance, transport, infrastructure), and services are favourable; UNESCO World Heritage sites exemplify this. Yet weak inter-firm linkages can limit increasing returns and local absorption of externalities. The NEG emphasises forward linkages that draw mobile factors (businesses, workers) toward markets, fostering co-location, shared services, and knowledge spillovers; backward linkages align with traditional geography by promoting sustainable resource use and mitigating externalities. Together, they create a self-sustaining mechanism linking attractions to final tourism products, forming a sustainable supply chain for agglomeration.

We argue that emerging tourism hotspots often resemble special economic zones, with development driven by infrastructure and incentives from central and local governments (Crouch and Ritchie, 1999; Faber and Gaubert, 2019; Li, 2004). Firms then relocate, market-size effects increase, and clusters form through backward linkages to nearby attractions. In established destinations, small and medium private firms typically lead development (Coles et al., 2014; Romao, 2020), highlighting stronger forward linkages and cumulative causation. Both Yang (2014) and Albaladejo et al. (2022) provide theoretical support for self-reinforcing tourism agglomeration. Hence, analyses should consider both tourism agglomeration and regional growth dependence. However, agglomeration need not always raise growth because immobile factors may not benefit; in our context, heritage sites are immobile.

2.4 Tourism-led economic growth

Although tourism's economic impact is well studied, findings are often inconsistent. National analyses report mixed results depending on countries, periods, and methods (Brida et al., 2016; Pulido-Fernandez and Cardenas-Garcia, 2021). Regional work generally treats tourism as a growth driver but differs from cross-country studies, which frequently rely on descriptive evidence, such as case studies, surveys, and observational narratives (Calero and Turner, 2020).

Only a few papers examine tourism's impact on regional growth. Cortes-Jimenez (2008) finds positive but region-specific effects in Spain and Italy: landlocked areas depend on domestic tourism, while Mediterranean regions benefit from both domestic and international flows. Paci and Marrocu (2014) show that tourism boosts growth in 179 regions across ten European countries, with nearby flows enhancing domestic tourism through interactions between visitors and operators, providing evidence of positive spatial influence. Andraz et al. (2015) report positive effects on output, employment, and investment across five Portuguese regions, including a "helping hand" that narrows the gap between the second- and third-largest regions. Ma et al. (2015) find that tourism development indirectly supports urban growth in China through positive spatial spillovers among cities, but not through direct local effects. Faber and Gaubert (2019) show tourism significantly advances local economies in Mexico relative to less touristic areas, with local gains partly offset by reduced agglomeration economies elsewhere. Bronzini et al. (2022) find international tourism raises growth more in less-developed Italian provinces than in established destinations, with location, tourist type, and development stage shaping outcomes.

These regional studies suggest that place-specific conditions mediate tourism-led growth. Yet, a systematic theoretical framework that integrates tourism into regional growth remains limited. Li et al. (2016) propose a simple neoclassical model in which tourism raises provincial labour productivity. Faber and Gaubert (2019) develop a multi-sector general equilibrium model with input–output linkages, government-financed tourism investment, and a labour-mobility trade-off between tourism and manufacturing; workers derive utility from local non-traded services, traded tourism services, and traded manufactures. While powerful, such calibrated models are demanding for practitioners. Building on this work, we offer a more accessible framework that embeds spatial dependence from an international economics perspective and can be tested across countries and regions using real data.

2.5 Theoretical framework

We develop a simple theoretical model of innovation-driven economic growth in a small open economy, considering knowledge spillovers to link tourism-related agglomeration and regional economic concentration based on the NEG. Regional economic growth is driven by information exchange and the dissemination of knowledge, as well as by various forms of capital accumulation, in line with the international economics literature (Coe and Helpman, 1995; Grossman and Helpman, 1991). This ideology aligns with the NEG in which economic agents interact, resulting in knowledge spillovers and increasing returns to scale. Our model is also supported by prior tourism studies and recent UK official reports, which show that innovation and human capital have driven tourism productivity and regional economic growth (Crouch and Ritchie, 1999; Gardiner et al., 2013; Government Policy Paper, 2021; McCann, 2020).

Regional productivity comprises local labour productivity and the contribution of "trading partners", i.e., tourism-related demand. Tourism exposes destinations to diverse cultures through interactions with individuals from various cultures, fostering cultural exchange, increasing the variety of goods and services available, and thereby enhancing productivity (Crouch and Ritchie, 1999). Similar ideas also appear in Li et al. (2016) and Faber and Gaubert (2019). Alternatively, one may argue that tourists interact with tourism options, including a package of attractions and all goods and services available at the destination (Albaladejo et al., 2022; Yang, 2014). Hence, tourism can affect a region's productivity and that of its neighbouring regions through tourism-related agglomeration. However, the sign and magnitude may vary, depending on the net effect of competition (for example, price and rental competition, congestion) and cooperation (such as tourist boards or supply chains).

Simultaneously, regional productivity is affected by neighbouring regions' productivity (Fingleton, 2001; Fischer, 2011; Lopez-Bazo et al., 2004). Overall, regional economic growth may converge or diverge, depending on the interplay of economic convergence effects arising from diminishing returns to economic activities and agglomeration effects (Delgado et al., 2014; Lopez-Bazo et al., 2004). Model details and derivations are provided in the Supplementary Material Section C. The output per capita in region i is given as follows, providing the foundation for our empirical model:

$$y_i = \bar{\theta}_i^{\frac{1}{1-\xi}} K_i^{a_{ii}} H_i^{b_{ii}} T_i^{c_{ii}} \prod_{j \neq i}^{N} K_j^{a_{ij}} H_j^{b_{ij}} T_j^{c_{ij}}$$

where K, H and T stands for physical capital, human capital and tourism-related activities, respectively. $\overline{\theta_i}$ is a region-specific factor capturing regional heterogeneities due to endowments and locations. For technical details, see Ertur and Koch (2007) and Fischer (2011). For an advanced theoretical model in future research, see Fingleton (2001).

3. Data and Empirical Strategy

3.1 Data and variable definitions

Our empirical analysis uses data covering all NUTS3 regions (133) in England from 2013 to 2019, excluding periods affected by the 2008/09 financial crisis and the COVID-19 pandemic.[1] Since the NUTS3 attraction-visit data covers only a short time period, panel analysis could mistake long-standing regional differences in attraction density for actual changes in attraction visits over time.[2] To avoid this, we compute the average of each variable over the available years and use this single cross-section to reduce the risk of spurious statistical relationships arising from limited within-region variation.

Regional economic growth is measured by real per capita GDP, following previous studies (Cortes-Jimenez, 2008; Ma et al., 2015; Paci and Marrocu, 2014). Our key explanatory variable is visits to heritage attractions, measured using VisitEngland-recorded visits to heritage attractions aggregated to the NUTS3 level and scaled by local accommodation capacity. We therefore interpret this indicator as an operational proxy for tourism-related demand rather than as a pure measure of tourist arrivals. We further distinguish two subcategories: Museums and Art Galleries (MG), and Historic Properties (HP), including castles or forts and historic monuments or archaeological sites.[3] We also consider visits to all attractions, including both heritage and non-heritage attractions, where

[1] No similar tourism data are available for other regions in the UK.
[2] We thank one referee for making this suggestion.
[3] Heritage visitor centres, heritage railways, and other historic properties are not used here because over half of the regions have no records.

the latter include country parks, farms or rare breeds, gardens, leisure or theme parks, nature reserves, wetlands or wildlife attractions, safari parks, zoos, aquariums or aviaries, science or technology centres, and other attractions.

Raw data on attraction visits are obtained from VisitEngland's Annual Survey of Visits to Visitor Attractions.[4] The survey is conducted annually by inviting eligible attractions in England to participate voluntarily. Attractions usually complete a self-administered online questionnaire, although postal responses are also accepted. If major attractions do not respond, VisitEngland supplements the data using trusted partners and local tourism bodies. The questionnaire design has remained broadly consistent across years to ensure comparability, with only occasional topical additions (Historic England, 2020).

We aggregate the attraction-level data to the NUTS3 level in order to combine them with regional economic data. Unfortunately, regional data on bed nights and tourism expenditure or receipts are not available at either the attraction or the NUTS3 level, which constrains the analysis. Overall, our dataset covers 1,161 attractions, of which 77.86% are heritage attractions. We include sites only if they report positive visitor numbers during the sample period, even if not in consecutive years. The data do not distinguish consistently between local visitors, domestic non-local visitors, and international visitors at the NUTS3 level. Accordingly, our visit-based indicators should be interpreted as measures of realised visitor demand at attractions rather than as pure tourist-arrival measures.

To account for the regional supply side of tourism services, we use the total number of bed spaces available in both serviced and non-serviced establishments, obtained from the VisitEngland Accommodation Stock Audit for 2016. The original data were collected at the NUTS4 level and matched to the corresponding NUTS3 regions. As noted in previous studies, regional differences in accommodation infrastructure can shape tourism-led regional growth (Albaladejo et al., 2022; Bernini et al., 2017; Pompili et al., 2019). In this context, accommodation capacity captures an important supply-side dimension of the local tourism economy. Because total beds and attraction visits are closely related, using them separately raises concerns about multicollinearity. We therefore construct the ratio of attraction visits to total beds as a more robust visit-based indicator, capturing realised demand relative to local accommodation capacity in a single measure.

Depending on tourism management and regional planning, local tourism incomes may rise or fall, influenced by regional differences (Bronzini et al., 2022). We account for these

[4] See VisitEngland website for more information (accessed 21 February 2023).

differences with regional control variables, including real per capita GDP based on its 2000 level, investment rate, human capital growth, and labour productivity growth, following previous studies (Cortes-Jimenez, 2008; Delgado et al., 2014; Li et al., 2016; Ma et al., 2015). Supplementary Material Section A (Tables S1-S2) provides detailed variable definitions, data sources, and summary statistics for all variables in use.

3.2 Methodology and econometric modelling

Based on the theoretical framework, we adopt the spatial Durbin model (SDM) to capture both economic growth dependence and tourism-related agglomeration:

$$Growth_i = \alpha_0 + \alpha_1\, Urban_i + \alpha_2\, Coast_i + \kappa GDPPC_{i,2000} + \rho W Growth_j + \gamma V\_H_i + \delta W V\_H_j + X_i \beta + W X_j \theta + \epsilon_i \qquad (1)$$

where V_H_i is proxied by our indicator of visits to heritage attractions in region i ($j \neq i$ indicating neighbouring regions). X_i contains other spatially dependent explanatory variables. $GDPPC_{i,2000}$ stands for real per capita GDP in 2000, and hence κ captures the classic economic convergence effect. Urban and coastal types capture regional heterogeneity in endowments and location. α_0 stands for a constant. ϵ_i is the idiosyncratic error term, and standard assumptions apply: $\epsilon_i \sim N(0, \sigma_\epsilon^2)$ and $E(\epsilon_i \epsilon_j) = 0$ for $i \neq j$.

The spatial weight matrix (W) is pre-determined and row-standardised. Given the modest sample size (133), we use the k-nearest neighbour spatial weight matrix. Pre-regression Moran's *I* test results for regional growth and different visit indicators are summarised in Supplementary Material Section B (Table S3), alongside visual examinations. Post-estimation Moran's *I* test results are reported in the main result tables using $k = 7$. For robustness checks, we also use $k = 5$ and $k = 10$

Past studies also suggest that different heritage attractions can influence tourism-led economic growth (Bellandi et al., 2020; Panzera et al., 2021; Pompili et al., 2019). Heritage assets represent a region's cultural values, shaping local tourism-related activity and economic clusters, making some attractions more effective at generating income. Therefore, we further estimate (1) using two subcategories of heritage sites: Historic Properties (V_HP) and Museums and Art Galleries (V_MG). Given that the uneven distribution of heritage sites is due to historical reasons and cannot be changed, other attractions can be developed for economic reasons. Although non-heritage attractions account for a smaller share of the UK tourism sector, we believe they still make a significant contribution. Consequently, we include visits to all attractions (V), both heritage and non-heritage, in our analysis.

Estimating (1) directly raises concerns about endogeneity. First, spatial feedback effects arise from both growth clustering and tourism-related concentration (Anselin, 1988; LeSage and Pace, 2009). Second, tourism and regional growth may be jointly determined by two-way causality (Brida et al., 2016; Pulido-Fernandez and Cardenas-Garcia, 2021). Therefore, different model specifications are estimated using 2SLS (see Anselin, 1988). The two-way causality between attraction visits and regional growth is corrected using climate instruments (Ivlevs and Smith, 2022). Arguably, regional climate conditions are correlated with attraction visits but do not influence regional growth through other explanatory variables. Specifically, we use cumulative seasonal temperature and precipitation instruments for spring (January-March), summer (April-June), autumn (July-September), and winter (October-December).[5] We also use two external instruments, past regional growth (2006-2012 average) and population density, to address endogeneity in the spatial lag of growth. To be more specific, in the first stage, we estimate:

$$WGrowth_i = X_{0,i}\xi_1 + X_i\varsigma_1 + \tilde{Z}_i\iota_1 + W\tilde{Z}_i\phi_1 + WX_i\psi_1 + W^2X_i + u_i \quad (2)$$

$$V\_H_i = X_{0,i}\xi_2 + Z_i\phi_2 + X_i\varsigma_2 + v_i \quad (3)$$

$$WV\_H_i = X_{0,i}\xi_3 + WZ_i\phi_3 + X_i\varsigma_3 + WX_i\psi_3 + \varpi_i \quad (4)$$

where Z_i and $\tilde{Z}_i$ stand for external instruments for attraction visits and regional growth, respectively. X_i stays the same as in (1); $X_{0,i}$ contains a constant, real per capita GDP in 2000, urban and coastal types. u_i , v_i and ϖ_i are idiosyncratic error terms; standard assumptions apply, and $E(u_i|\tilde{Z}_i, X_i) = 0$, $E(v_i|Z_i, X_i) = 0$, $E(\varpi_i|Z_i, X_i) = 0$. We use (2)-(4) to predict the endogenous variables in the first stage, then plug these predictions into (1) to estimate the SDM in the second stage. Note that ρ in (1) is not a structural parameter, but an estimated one, i.e., $\hat{\rho}$. For estimated coefficients and spatial lagged coefficients, spatial HAC-robust standard errors (Kelejian and Prucha, 2007) are used. The standard errors of direct, indirect and total effects are computed using the Delta method.

We assess instrument relevance using Sanderson-Windmeijer partial F tests (Sanderson and Windmeijer, 2016) for multiple endogenous regressors and the Kleibergen-Paap rk Wald test (Kleibergen and Paap, 2006) as a joint weak-instrument diagnostic. Overidentification and instrument endogeneity are evaluated with the Hansen J and Durbin-Wu-Hausman tests after the second stage. All tests use spatial HAC-robust standard errors (Kelejian and Prucha, 2007). To ensure robustness, we re-estimate with a two-step GMM,

[5] The raw UK climate data were recorded at 2km resolution. We aggregated them to regional averages and merged them into NUTS3 areas for analysis.

consider alternative spatial weights, and include heritage-site and attraction counts to formally test whether fixed attraction distribution (rather than visit dynamics) drives the results.

4. Empirical Results

4.1 Visits to heritage attractions and regional economic growth

In spatial models, an outcome in one unit can affect other units through spatial dependence. Accordingly, we report direct, indirect, and total marginal effects, along with the coefficients on each variable and its spatial lag. Table 1 presents the estimated impact of visits to heritage attractions on regional growth using 2SLS (left panel) and two-step GMM (right panel).

Overall, we observe statistically significant positive regional growth dependence, indicated by a positive estimated $\hat{\rho}$. A one-percentage-point increase in neighbouring regions' growth contributes 0.51 (2SLS) or 0.69 (GMM) percentage points to local growth. This confirms the clustering of regional economic growth, shedding light on England's persistent regional divide. The traditional conditional convergence co-exists under the assumption of a common steady state, which could be examined in future studies. Coast type does not affect growth, while greater rural concentration reduces it.

More importantly, we find a statistically significant positive direct effect of visits to heritage attractions (V_H) on regional growth, which translates into a positive overall impact and is consistent with the NEG framework. A 1% increase in V_H directly contributes 0.0006 (2SLS) or 0.0008 (GMM) percentage points to regional growth. While these coefficients appear small, their cumulative effect under GMM is meaningful. Doubling V_H increases regional growth by 0.09 percentage points. Considering that average and median regional growth rates in our sample are only about 1%, this effect is substantial and policy-relevant, even if smaller than that of regional growth dependence. More specifically, an interquartile increase in V_H from the 25th percentile to the 75th percentile, increases regional growth by 0.11 percentage points, equivalent to about 11% of average annual growth.

For other spatially dependent control variables, we find evidence of positive direct effects of productivity growth, investment rate, and human capital growth on regional growth, supporting our theoretical model. These results also align with previous UK studies (Gardiner et al., 2013; Government Policy Paper, 2021). Furthermore, investment rate and human capital growth also have positive indirect and total effects on regional growth, while productivity growth displays a competition effect but no significant total effect. The magnitudes are consistent across 2SLS and GMM. Specifically, a one-percentage-point increase in productivity growth, the investment rate and human capital growth contributes 0.2, 0.03, and 0.02 percentage points of direct effects, respectively. Regarding total effects, a one-percentage-point increase in investment rate and human capital growth contributes 0.20 (2SLS) and 0.22 (GMM), and 0.59 (2SLS) and 0.75 (GMM) percentage points, respectively.

Notably, the direct effect of V_H is smaller than that of productivity growth, yet broadly comparable in magnitude to the investment rate and human capital growth under both 2SLS and GMM. For a one-standard-deviation increase, the direct marginal effects of V_H are 0.09 percentage points (2SLS) and 0.12 percentage points (GMM). The corresponding figures are 0.32/0.34 percentage points for productivity growth (2SLS/GMM), 0.14/0.12 percentage points for the investment rate, and 0.027 percentage points for human capital growth (2SLS and GMM). Thus, the direct effect of V_H is smaller than productivity, similar to investment, and larger than human capital. Turning to total effects, a one-standard-deviation increase in V_H contributes 0.21 percentage points to regional growth under GMM. In contrast, the investment rate and human capital growth each contribute 0.96 percentage points under GMM. Hence, investment and human capital clearly dominate V_H in total effects.

A plausible explanation is that V_H acts primarily as a local demand shock, raising spending and activity in the vicinity of the attractions and resulting in a sizable direct effect comparable to investment, larger than that of human capital. However, its indirect propagation is weaker. Heritage sites are immobile and capacity-constrained; visitor flows can reallocate demand across neighbouring regions (competition for tourists), and a portion of spending leaks to non-local suppliers. By contrast, investment and human capital expand the production base, thereby deepening input-output linkages and labour-market networks that span regional boundaries, resulting in more substantial spillovers, which lift total effects above those associated with attraction visits.

Post-estimation tests have all passed. Kleibergen-Paap rk F-statistic and Sanderson-Windmeijer partial F-test statistics indicate that our instruments are strong. Hansen *J* test and Durbin-Wu-Hausman test show that the instrumented endogenous variables are exogenous. Moran's *I* test shows no spatial autocorrelation in the residuals.

Next, we recompute the visit indicator using all attractions (heritage and non-heritage) and report its impact on regional growth in Table 2. The dependence of regional growth remains consistent with Table 1. A one-percentage-point increase in neighbouring regions' growth contributes 0.48 (2SLS) or 0.67 (GMM) percentage points to local growth.

Conditional convergence persists, and urban type shows a significant negative effect. For visits to all attractions (V), we still observe positive direct but insignificant total effects, while 2SLS also reveals a negative indirect effect. Specifically, a 1% increase in V raises local growth by 0.0008 (2SLS) or 0.0007 (GMM) percentage points, but may reduce neighbouring growth by 0.0012 points. Results for other spatially dependent controls remain largely unchanged from Table 1, except that GMM captures a positive overall effect of productivity growth. All post-estimation tests have passed.

Table 1. Visits to heritage attractions (V_H), $W: k = 7$

Dep: Growth (n = 133)	2SLS					Two-step GMM				
	(1) Main	(2) WX	(3) Direct	(4) Indirect	(5) Total	(6) Main	(7) WX	(8) Direct	(9) Indirect	(10) Total
Urban	-0.2018***					-0.2152***				
	(0.0122)					(0.0087)				
Coast	-0.0060					0.0002				
	(0.0081)					(0.0080)				
$GDPPC_{2000}$	-0.0632**					-0.0942***				
	(0.0247)					(0.0177)				
Productivity	0.2251***	-0.2172***	0.2169***	-0.2007***	0.0161	0.2367***	-0.2272***	0.2275***	-0.1975***	0.0300
growth	(0.0065)	(0.0128)	(0.0072)	(0.0271)	(0.0320)	(0.0046)	(0.0107)	(0.0052)	(0.0336)	(0.0368)
Investment rate	0.0262***	0.0708***	0.0331***	0.1668***	0.1998***	0.0184***	0.0515***	0.0275***	0.1949***	0.2224***
	(0.0021)	(0.0062)	(0.0022)	(0.0123)	(0.0133)	(0.0018)	(0.0042)	(0.0020)	(0.0190)	(0.0201)
Human capital	-0.0020	0.2893***	0.0213***	0.5706***	0.5919***	-0.0128***	0.2494***	0.0210***	0.7307***	0.7517***
growth	(0.0052)	(0.0152)	(0.0047)	(0.0422)	(0.0434)	(0.0042)	(0.0116)	(0.0051)	(0.0580)	(0.0610)
V_H	0.0564***	-0.0399***	0.0556***	-0.0215	0.0341	0.0747***	-0.0348***	0.0770***	0.0499	0.1269***
	(0.0128)	(0.0149)	(0.0126)	(0.0248)	(0.0263)	(0.0059)	(0.0105)	(0.0065)	(0.0373)	(0.0407)
$\hat{\rho}$	0.5146***					0.6853***				
	(0.0403)					(0.0235)				
Kleibergen-Paap rk F-statistic	31.25									
Sanderson-Windmeijer partial F-test:										
Visits	6.011*** (0.0000)									
WGrowth	3.215*** (0.0021)									
WVisits	26.72*** (0.0000)									
Hansen *J* test	30.65 (0.9366)					22.12 (0.8150)				
Durbin-Wu-Hausman test (joint):	3.008 (0.3904)					5.313 (0.1502)				
Visits	-0.9850 (0.3248)					-1.553 (0.1205)				
WGrowth	-0.5390 (0.5898)					-0.3560 (0.7217)				
WVisits	-1.170 (0.2420)					-1.183 (0.2369)				
Moran's *I* test	-0.0012 (0.9650)					-0.1204 (0.7679)				

Note: ***, ** and * denote 1%, 5% and 10% level of significance, respectively. Spatial HAC robust standard errors are reported in parentheses. For post-estimation tests, p-values are reported in parentheses. H_0 of Moran's *I* test is no spatial autocorrelation.

Table 2. Visits to all attractions (V), $W: k = 7$

Dep: Growth (n = 133)	2SLS					Two-step GMM				
	(1) Main	(2) WX	(3) Direct	(4) Indirect	(5) Total	(6) Main	(7) WX	(8) Direct	(9) Indirect	(10) Total
Urban	-0.1753***					-0.1795***				
	(0.0097)					(0.0082)				
Coast	0.0157*					0.0200**				
	(0.0086)					(0.0083)				
$GDPPC_{2000}$	-0.0893***					-0.1066***				
	(0.0242)					(0.0173)				
Productivity	0.2311***	-0.2187***	0.2233***	-0.1992***	0.0241	0.2398***	-0.1965**	0.2351***	-0.1028***	0.1323***
growth	(0.0063)	(0.0126)	(0.0069)	(0.0242)	(0.0287)	(0.0046)	(0.0110)	(0.0054)	(0.0331)	(0.0367)
Investment rate	0.0268***	0.0707***	0.0329***	0.1554***	0.1883***	0.0203***	0.0582***	0.0299***	0.2095***	0.2394***
	(0.0021)	(0.0060)	(0.0021)	(0.0106)	(0.0115)	(0.0017)	(0.0042)	(0.0020)	(0.0198)	(0.0209)
Human capital	-0.0023	0.2876***	0.0186***	0.5322***	0.5508***	-0.0167***	0.2509***	0.0155***	0.6989***	0.7144***
growth	(0.0049)	(0.0149)	(0.0044)	(0.0365)	(0.0376)	(0.0043)	(0.0119)	(0.0050)	(0.0543)	(0.0572)
V	0.0801***	-0.1029***	0.0754***	-0.1195***	-0.0441	0.0665***	-0.0479***	0.0661***	-0.0093	0.0568
	(0.0131)	(0.0179)	(0.0128)	(0.0272)	(0.0273)	(0.0062)	(0.0124)	(0.0065)	(0.0368)	(0.0393)
$\hat{\rho}$	0.4820***					0.6722***				
	(0.0398)					(0.0247)				
Kleibergen-Paap rk F-statistic	29.83									
Sanderson-Windmeijer partial F-test:										
Visits	6.128*** (0.0000)									
WGrowth	3.567*** (0.0008)									
WVisits	30.14*** (0.0000)									
Hansen *J* test	30.77 (0.9346)					21.42 (0.8433)				
Durbin-Wu-Hausman test (joint):	1.909 (0.5914)					2.767 (0.429)				
Visits	-1.034 (0.3010)					-1.306 (0.1917)				
WGrowth	-0.7240 (0.4692)					-0.5600 (0.5755)				
WVisits	-0.4190 (0.6755)					-0.4290 (0.6680)				
Moran's *I* test	0.0011 (0.9820)					-0.1253 (0.7581)				

Note: ***, ** and * denote 1%, 5% and 10% level of significance, respectively. Spatial HAC robust standard errors are reported in parentheses. For post-estimation tests, p-values are reported in parentheses. H_0 of Moran's *I* test is no spatial autocorrelation.

4.2 Different types of heritage attractions

Furthermore, we investigate whether the type of heritage attraction influences regional growth associated with visits to heritage attractions. We differentiate heritage sites by reflecting their relation to regional culture and tradition. Past studies suggest that heritage attractions with distinct cultural features attract different types of tourists and generate varying levels of spending. For example, historic properties, such as castles and palaces, are particularly popular among visitors motivated by tradition. In contrast, museums and art galleries are more appealing to those who are creative, curious, and focused on educational purposes driven by cultural differences (Bellandi et al., 2020; Panzera et al., 2021; Pompili et al., 2019).

Table 3 reports the 2SLS estimation results, while the GMM results are briefly summarised in Supplementary Material Section D (Table S4, Panel C). We continue to find positive spatial dependence in regional economic growth. Results for other spatially dependent controls align with those in Tables 1-2. All post-estimation tests have passed.

The impact of visits to heritage attractions varies by site type. V_HP has a statistically significant positive direct effect but a negative indirect effect, yielding a small negative total effect under 2SLS. This pattern is consistent with competition across regions, where stronger heritage promotion in one location may divert visitors from nearby areas rather than generate entirely new demand. By contrast, V_MG exhibits statistically significant indirect and total effects and, under GMM, also a positive direct effect. Quantitatively, a 1% increase in V_HP raises local growth by 0.0015 (2SLS) or 0.0012 (GMM) percentage points, but may lower neighbouring growth by 0.0023 (2SLS) or 0.0014 (GMM).

V_MG tends to be more beneficial for neighbouring regions, as doubling V_MG raises their growth by 0.07 percentage points in both 2SLS and GMM, with a similar magnitude for the total effect. Although the marginal effect per 1% increase in V_MG is small, the implied impact of more realistic changes is economically meaningful. Doubling V_MG increases regional growth by 0.07 percentage points, equivalent to 7% of the average annual growth rate, given that the average regional growth rate in our sample is about 1%. Moving from the median to the 75th percentile of V_MG intensity raises growth by 0.08 percentage points, and from the median to the 90th percentile by 0.13 percentage points. These results show that visits to museums and art galleries (V_MG) and to historic properties (V_HP), along with visits to heritage attractions (V_H) and to attractions overall (V) as presented in Tables 1-3, contribute a significant share of regional growth in the UK, where annual growth rates are modest.

Table 3. Different types of heritage attractions ($W: k = 7$)

Dep: Growth ($n = 133$)	2SLS					2SLS				
	(1) Main	(2) WX	(3) Direct	(4) Indirect	(5) Total	(6) Main	(7) WX	(8) Direct	(9) Indirect	(10) Total
Urban	-0.2608***					-0.1526***				
	(0.0176)					(0.0102)				
Coast	0.0032					0.0020				
	(0.0074)					(0.0079)				
GDPPC_{2000}	-0.1503***					-0.0085				
	(0.0252)					(0.0227)				
Productivity	0.2572***	-0.2390***	0.2485***	-0.2111***	0.0374	0.2156***	-0.2276***	0.2056***	-0.2329***	-0.0273
growth	(0.0071)	(0.0121)	(0.0077)	(0.0251)	(0.0302)	(0.0059)	(0.0135)	(0.0067)	(0.0328)	(0.0374)
Investment rate	0.0237***	0.0722***	0.0305***	0.1670***	0.1975***	0.0253***	0.0615***	0.0323***	0.1643***	0.1966***
	(0.0020)	(0.0060)	(0.0020)	(0.0114)	(0.0122)	(0.0022)	(0.0062)	(0.0023)	(0.0129)	(0.0140)
Human capital	0.0228***	0.2987***	0.0479***	0.6146***	0.6625***	-0.0036	0.3316***	0.0270***	0.7156***	0.7426***
growth	(0.0056)	(0.0149)	(0.0054)	(0.0432)	(0.0451)	(0.0049)	(0.0164)	(0.0048)	(0.0606)	(0.0626)
V_HP	0.1563**	-0.1984***	0.1467***	-0.2336***	-0.0869***					
	(0.0166)	(0.0150)	(0.0167)	(0.0265)	(0.0334)					
V_MG						0.0105	0.0465***	0.0154	0.1138***	0.1291***
						(0.0128)	(0.0122)	(0.0127)	(0.0241)	(0.0266)
$\hat{\rho}$	0.5147***					0.5583***				
	(0.0383)					(0.0402)				
Kleibergen-Paap rk F-statistic	26.02					24.78				
Sanderson-Windmeijer partial F-test:										
Visits	2.202** (0.0243)					4.652*** (0.0000)				
WGrowth	5.713*** (0.0000)					3.392*** (0.0013)				
WVisits	25.50*** (0.0000)					42.82*** (0.0000)				
Hansen J test	29.54 (0.9534)					29.78 (0.9501)				
Durbin-Wu-Hausman test (joint):	4.723 (0.1932)					1.685 (0.6402)				
Visits	-1.374 (0.1696)					-0.4550 (0.6492)				
WGrowth	-1.088 (0.2765)					-0.3560 (0.7218)				
WVisits	-0.9570 (0.3388)					-0.9620 (0.3360)				
Moran's I test	-0.0059 (0.8870)					-0.0046 (0.9250)				

Note: ***, ** and * denote 1%, 5% and 10% level of significance, respectively. Spatial HAC robust standard errors are reported in parentheses. For post-estimation tests, p-values are reported in parentheses. H_0 of Moran's I test is no spatial autocorrelation.

4.3 Robustness checks

We conducted several robustness checks to confirm our main findings. First, we tested different spatial weight matrices ($k = 5, 7$ and 10), with the key estimates summarised in Supplementary Material Section D (Table S4). Across different specifications, positive economic growth dependence persists. We also find statistically significant positive total effects for V_H and V when $k = 5$ and 10, supporting the NEG framework. Overall, four visit indicators display positive direct and total effects, while some negative indirect effects emerge. These results suggest that although attraction visits in one region may slightly crowd out neighbouring growth, the net contribution is positive.

We next test whether our results are driven by systematic differences in the distribution of attractions rather than visit dynamics by removing the effect of attraction counts from visit indicators. Specifically, we predict visits to heritage attractions and attractions overall using the corresponding site counts, their spatial lags, and the other controls as in (1), and then use the residuals in the 2SLS and GMM estimations. The results remain consistent (see Table S5). Visits to heritage attractions and attractions overall continue to show significant positive direct, indirect, and total effects, with indirect effects larger than direct ones. Full robustness check results are available upon request.

5. Conclusions

5.1 Summary of findings

We find a statistically significant positive direct effect of visits to heritage attractions on regional growth, yielding a positive overall impact and supporting the NEG framework. Doubling visits to heritage attractions raises growth by 0.09 percentage points; an interquartile shift increases it by 0.11 percentage points (about 11% of the average annual growth rate of 1%).

For overall attraction visits, direct effects are positive, while indirect effects depend on the spatial weight matrix: spillovers can be negative (competition), yet total effects can still be positive. When we remove attraction counts from visit indicators, both of them show positive direct, indirect, and total effects, with indirect exceeding direct.

Effects also differ by site type. Historic Properties (HP) visits have positive direct but negative indirect effects, though total effects turn positive under alternative estimators or weight matrices. Museums and Art Galleries (MG) visits benefit neighbours more: doubling MG raises growth by 0.07 percentage points (7% of average annual growth), with similar total effects across 2SLS and GMM and smaller direct effects under alternative specifications.

Finally, we document persistent spatial growth dependence across regions, irrespective of performance. This pattern supports the NEG view that uneven spatial concentration, driven by market potential and agglomeration spillovers, shapes the growth impact of visits to heritage attractions.

5.2 Theoretical implications

This study advances the tourism-led growth literature by offering regional evidence from a new economic geography perspective and addressing gaps noted by Calero and Turner (2020).

First, our theoretical model extends regional growth frameworks that account for spatial dependence (Fingleton, 2001; Fischer, 2011; Lopez-Bazo et al., 2004) and incorporates regional productivity (Li et al., 2016; Faber and Gaubert, 2019) to link international trade in services to regional agglomeration, which is rare in tourism research. The framework is expressly testable and clarifies how tourism-related agglomeration may affect growth.

Second, we use a dataset distinguishing heritage from non-heritage sites, enabling a more precise evaluation of tourism-led growth. Because attraction type shapes demand and supply, our visit-based indicator, scaled by accommodation capacity, captures this dynamic in operational terms. Maximising positive spillovers therefore depends on effective heritage management and, from a marketing perspective, on differentiating heritage assets to create distinctive tourism products.

Third, our work highlights knowledge transfer for modelling growth in advanced economies. Globalisation and technological change have widened UK regional disparities (Gardiner et al., 2013; Morrissey, 2020), exacerbated by the pandemic and rising living costs. Our finding of positive regional growth dependence underscores the need to model inter-regional growth and tourism-related linkages; omitting them risks model misspecification and weak policy design.

5.3 Practical and policy implications

Our results suggest several recommendations. First, because both heritage-attraction and overall attraction visits foster regional growth, places with limited heritage should invest in iconic, purpose-built attractions to stimulate demand and support post-industrial transitions toward services (e.g., Glasgow's rebranding). Created resources can be more sustainable than natural ones (Crouch and Ritchie, 1999). If well managed by DMOs, such investments generate positive spillovers and support long-run growth.

Second, sustainable development is essential. Heritage-related agglomeration can reduce neighbouring growth, calling for careful resource management and positioning. Policymakers should differentiate attractions and promote regional and cross-sector collaboration to limit competition and create win-wins. Practical steps include staggering opening days of castles, monuments, and archaeological sites to reduce congestion and protect sites, and using travelling exhibitions in smaller museums and galleries to spread demand and relieve pressure on major venues, thereby aiding preservation in less accessible areas. More broadly, tourism, culture, and the creative economy are intertwined; visitor flows can also support cultural exchange and related creative industries, while integration with other sectors upgrades offerings and job quality.

Third, effective governance is pivotal. DMOs coordinate destinations, but balanced public-private governance, active networks, and clear economic rules are needed (Crouch and Ritchie, 1999). We find persistent spatial dependence, relatively weak conditional convergence, and lower growth with rural concentration. Without policy action, hotspots may outcompete less-accessible regions, risking divergence. Beyond new attractions, governments should curb excessive concentration and ensure that tourism-related demand benefits other sectors; otherwise, overspecialisation can crowd out other sectors (Paci and Marrocu, 2014; Romao et al., 2016). Strengthening regional supply chains can help turn tourism spillovers into broader agglomeration.

Lastly, to support struggling regions, tourism-related activity must raise productivity alongside regional productivity and human capital in line with standard theory. Tourism is often viewed as low-value and labour-intensive, especially given the UK's productivity gap; improving productivity is therefore vital. Low-value, labour-intensive tourism harms resilience (Romao, 2020), whereas high-value services and knowledge integration strengthen economies (Romao et al., 2016). Destinations should mobilise innovation and smart specialisation to reduce youth unemployment. Addressing UK skill gaps (Government Policy Paper, 2021; Morrissey, 2020) could involve university-industry partnerships that offer part-time apprenticeships in tourism, promote technology adoption, attract skilled workers, and improve student employability, thereby enhancing human capital and tourism's contribution to regional growth.

5.4 Limitations and ideas for future research

Our study has several limitations that point to directions for future research. First, the VisitEngland data record attraction visits, but they do not allow us to distinguish consistently between local visitors, domestic non-local visitors, and international visitors at the NUTS3 level. Our empirical indicators should therefore be interpreted as visit-based measures of tourism-related demand rather than pure measures of tourist arrivals. Richer regional data on visitor origin, length of stay, bed nights, and expenditure would enable future research to more clearly identify which demand components matter most for regional growth and well-being. Second, seasonality is likely to matter in a destination such as the UK. Monthly or quarterly regional data would enable examination of how seasonal fluctuations in visits shape local growth dynamics, congestion, and regional inequality. Finally, the analysis is constrained by the limited time span and the availability of regional tourism-related data. Because comparable NUTS3-level indicators are scarce, our ability to implement broader robustness checks is necessarily restricted, and the short sample period prevents an assessment of longer-run effects. Future research should therefore use longer panels and richer regional data to examine these mechanisms with greater precision.

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Supplementary Material

Section A. Data and basic statistics

Table S1. Variable definitions and data sources

Variable	Definition	Notes	Source
Growth	Real per capita GDP growth (%)	Chained volume measure in 2018 money value (£ million)	Office for National Statistics, UK (ONS), Regional Economic Activity (REA)
$GDPPC_{2000}$	ln(real per capita GDP in 2000)	Chained volume measure in 2018 money value (£ million)	ONS, REA
Productivity growth	Δln(regional labour productivity) × 100%	Chained volume measure (2022 = 100)	ONS, Subregional Productivity
Investment rate	Δln(gross total fixed capital formation) × 100%	The total fixed capital includes both tangible and intangible capital.	ONS, REA
Human capital growth	Δln(employment in knowledge-intensive industries/total employment) × 100%	29 selected industries include knowledge-intensive market and financial services, high-tech services and other knowledge-intensive services (2-digit SIC codes: 50-51, 58-66, 69-75, 78, 80, 84-88 and 90-93).	ONS, Annual Population Survey
Urban	Urban type	Categorical: 1 (predominantly urban regions), 2 (intermediate regions) and 3 (predominantly rural regions).	Eurostat
Coast	Coast type	Categorical: 1 (coastal regions), 2 (partially coastal regions) and 3 (inland regions).	Eurostat
V_H	ln(1 + visits to heritage attractions/total beds)	"Visits to heritage attractions" refers to visitor demand for heritage attractions, using VisitEngland-recorded visits. "Total beds" is defined as the total number of beds in accommodation facilities in 2016, including both serviced (i.e., hotels and similar establishments) and non-serviced establishments. The non-serviced establishments cover holiday	VisitEngland, Annual Survey of Visits to Visitor Attractions (ASVVA) and Accommodation Stock Audit in 2016

		dwellings, tourist campsites and other collective accommodations. Note that this measure captures visitor demand for heritage attractions relative to local accommodation capacity.	
V	ln(1 + visits to all attractions/total beds)		VisitEngland, ASVVA
V_HP	ln(1 + visits to historic properties/total beds)	Historic properties include Castles (or forts) and Historic monuments (or archaeological sites).	VisitEngland, ASVVA
V_MG	ln(1 + visits to Museums and Art Galleries/total beds)		VisitEngland, ASVVA
H_count	ln(1 + number of heritage sites)		VisitEngland, ASVVA
A_count	ln(1 + number of all attractions)		VisitEngland, ASVVA
Past growth	Real per capita GDP growth between 2006 and 2012 (%)	Chained volume measure in 2018 money value (£ million)	ONS, REA
Population density	ln(population/shape area size)	Shape area size is measured in square kilometres (km^2)	ONS, REA; ONS Geography
Cumulative seasonal temperature degrees (°C)	Cumulative seasonal temperature	Spring (January-March), summer (April-June), autumn (July-September), and winter (October-December).	Met Office Climate Data Portal, UK
Cumulative seasonal precipitation (mm)	Cumulative seasonal precipitation	Spring (January-March), summer (April-June), autumn (July-September), and winter (October-December).	Met Office Climate Data Portal, UK

Table S2. Descriptive statistics

Variable	Mean	Median	Std.	Min	Max	Skew	Kurt	Obs.
Growth	1.019	1.029	0.9176	-1.786	4.429	0.4363	5.866	133
$GDPPC_{2000}$	10.12	10.06	0.3865	9.591	12.50	3.445	20.43	133
Productivity growth	0.5523	0.5246	1.479	-4.383	4.891	-0.0435	3.923	133
Investment rate	5.440	5.171	4.307	-7.166	17.62	0.2203	3.670	133
Human capital growth	0.3676	0.5872	1.280	-3.005	4.479	-0.2054	3.650	133
V_H	2.717	2.997	1.619	0	6.485	-0.2265	2.306	133
V	3.247	3.500	1.632	0	7.223	-0.5069	2.741	133
V_HP	1.885	1.834	1.517	0	6.081	0.2328	2.086	133
V_MG	1.619	1.143	1.655	0	6.289	0.7859	2.515	133
H_count	1.874	1.946	0.9700	0	3.714	-0.3541	2.308	133
A_count	1.650	1.792	0.9625	0	3.401	-0.2507	2.113	133
Past growth	0.0377	-0.0286	0.8552	-2.271	3.9	0.7093	5.780	133
Population density	6.853	6.753	1.360	3.980	9.538	0.0523	2.068	133
Urban	1.256	1	0.4870	1	3	1.696	4.994	133
Coast	1.737	2	0.7967	1	3	0.5048	1.760	133
Temperature spring	16.58	16.29	2.008	11.02	20.72	-0.2076	3.045	133
Temperature summer	36.21	36.31	2.549	28.97	41.76	-0.3230	3.377	133
Temperature autumn	48.39	48.43	2.896	40.47	53.98	-0.3809	3.045	133
Temperature winter	23.64	23.38	2.300	17.62	28.51	-0.0911	2.778	133
Precipitation spring	183.2	162.5	59.01	116.6	409.6	1.586	5.441	133
Precipitation summer	166.9	160.1	29.04	121.8	276.7	1.260	4.738	133
Precipitation autumn	194.0	180.8	45.78	134.8	391.0	1.832	6.708	133
Precipitation winter	247.3	220.3	72.73	163.6	534.1	1.435	4.944	133

Section B. Visual examinations and pre-regression tests

When visitors go to a particular attraction, they may also go to nearby attractions. Therefore, the number of tourists visiting different sites is not independent of each other, but rather, it shows spatial correlation. This means that tourist visitor numbers tend to be similar across neighbouring attractions (either high or low), indicating spatial clustering. Heritage attractions may exhibit stronger spatial clustering in visits than some non-heritage attractions. In addition, certain regions in the UK, such as London and the South East, tend to benefit from higher economic growth than others. While studying the impact of attraction visits (or tourism-related demand) on regional growth, it is crucial to consider the spatial effects of both economic growth and tourism.

Before analysing the data, we plot maps to investigate spatial dependence. Figure S1 shows average regional growth, with darker colours indicating faster growth. National economic growth in the UK is usually between 1% and 3%. Regions experiencing faster growth are mainly concentrated in inner London, most of Yorkshire and the Humber (Y&H), a part of South East (SE), West Midlands (WM), East Midlands (EM), and East of England (EAST). In contrast, North East (NE), a part of Greater London, North West (NW), and East of England (EAST) have less than 1% or even negative growth during the sample period. Figure S2 displays average regional visits to heritage attractions. Warm (cool) colours indicate tourism hotspots (coldspots). Historical reasons seem to affect the distribution of heritage tourism hotspots significantly. South West (SW), a part of South East (SE), and some orange-coloured hotspots tend to have more heritage assets. Greater London has both tourism hotspots and coldspots. Overall, regional economic growth and heritage tourism are each geographically concentrated, but it is not always clear that they are positively associated.

We then perform Moran's *I* test for regional growth and different tourism indicators using various nearest neighbours spatial weight matrices ($k = 5, 7$ and 10). Regional growth and some visits indicators exhibit statistically significant weak positive spatial autocorrelations, with exceptions in V_H and V, as indicated in Table S3. In contrast, attractions (H_count and A_count) tend to exhibit stronger spatial dependence. We also checked the correlation matrix for all variables in use and found no sign of multicollinearity, which is available upon request.

Table S3. Moran's *I* test (pre-regression)

Variable	$k = 5$	$k = 7$	$k = 10$
Growth	0.063* (0.073)	0.051* (0.076)	0.044* (0.062)
V_H	0.017 (0.312)	-0.010 (0.476)	0.010 (0.303)
V	0.005 (0.403)	-0.022 (0.368)	-0.003 (0.446)
V_HP	0.069* (0.061)	0.048* (0.092)	0.052** (0.040)
V_MG	0.073* (0.051)	0.055* (0.066)	0.086*** (0.003)
H_count	0.110*** (0.009)	0.084** (0.014)	0.088*** (0.003)
A_count	0.154*** (0.001)	0.123*** (0.001)	0.121*** (0.000)

Note: ***, ** and * denote 1%, 5% and 10% level of significance, respectively. H_0 of Moran's *I* test is no spatial autocorrelation. P-values are reported in parentheses.

Figure S1. Regional economic growth rate (%)

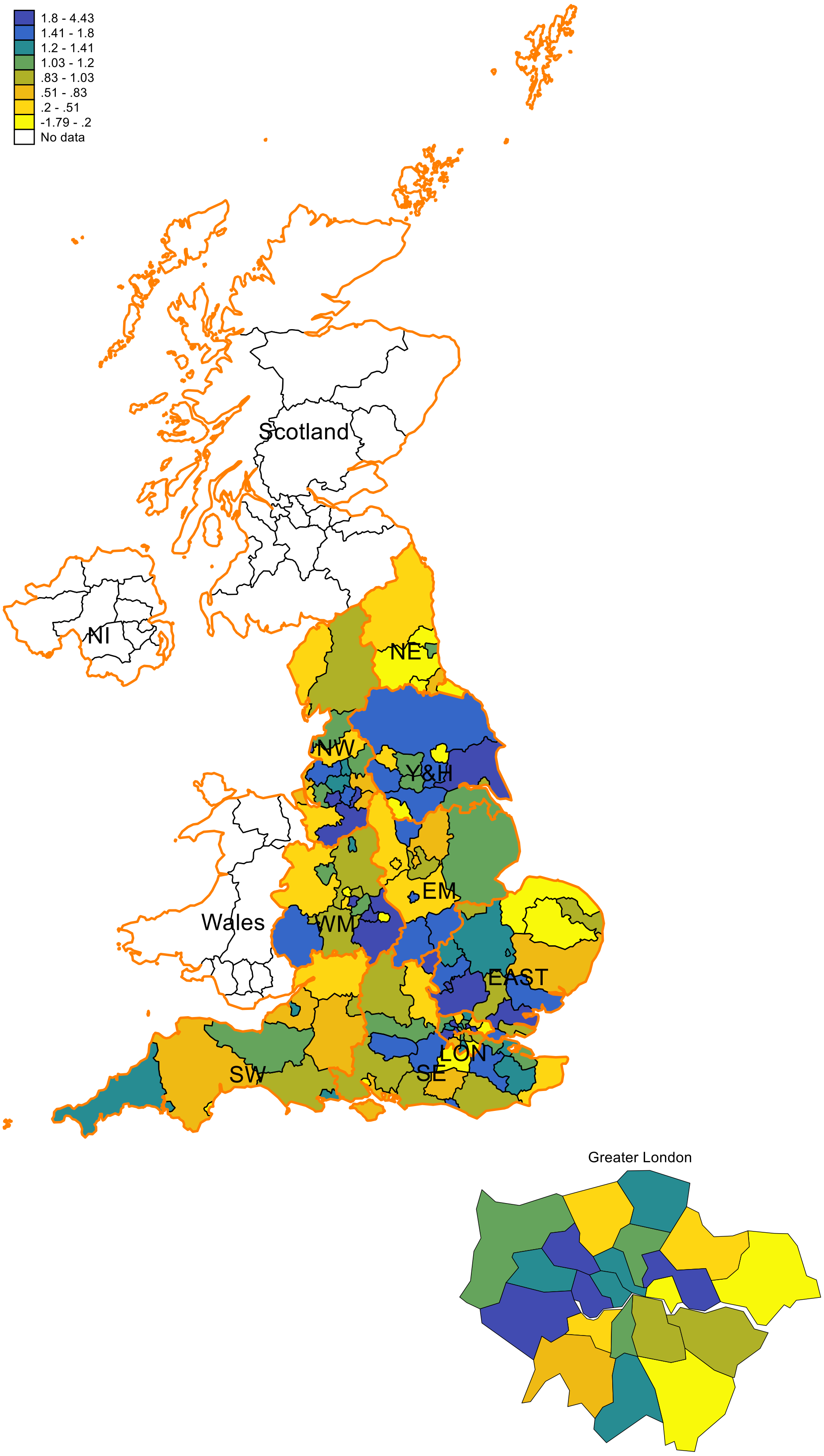
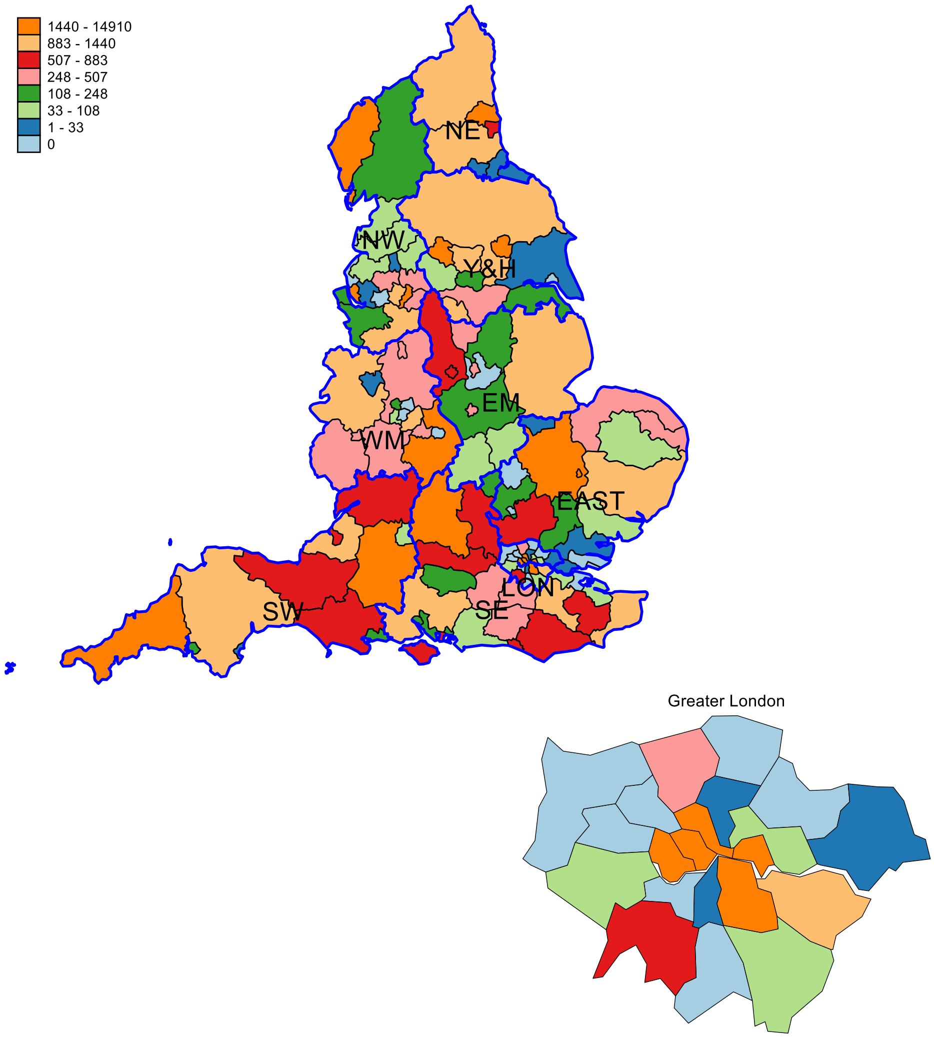


Figure S2. Regional visits to heritage attractions (in thousands)



Section C. Derivation of the theoretical model

Region i's output (per capita) in year t is specified below:

$$y_{i,t} = \theta_{i,t} K_{i,t}^{\alpha} H_{i,t}^{\beta} T_{i,t}^{\gamma} \tag{1}$$

where $K_{i,t}$, $H_{i,t}$ and $T_{i,t}$ stand for physical capital, human capital and tourism-related activity per capita, respectively, $\alpha, \beta, \gamma \in (0,1)$ and $\alpha + \beta + \gamma < 1$, indicating diminishing returns to scale for each input. γ represents the output elasticity with respect to visitor-related tourism activity (see Li et al., 2016). One may also consider that it describes the strength of intra-tourism through attraction-based tourism activity, assuming diminishing returns to scale in tourism and accounting for negative externalities such as congestion and housing price inflation.

$\theta_{i,t}$ is regional productivity, which depends on its region-specific productivity and neighbouring regions' productivity, reflecting intra- and inter-regional knowledge spillovers or technological interdependence (see Ertur & Koch, 2007; Fischer, 2011). To be more specific, we have:

$$\theta_{i,t} = \bar{\theta}_\iota K_{i,t}^{\alpha'} H_{i,t}^{\beta'} T_{i,t}^{\gamma'} \prod_{j\neq i}^{N} \theta_{j,t}{}^{\xi w_{ij}} \quad (2)$$

where $\overline{\theta_\iota}$ is a region-specific factor capturing regional heterogeneities due to endowments and locations. Next, knowledge and technology are assumed to be embodied in physical capital, human capital and tourism activities. $\alpha', \beta', \gamma' \in [0, 1)$ represent intra-regional externalities, which may take 0, suggesting no intra-regional spillover. Overall, they capture economic convergence effects due to diminishing returns on economic activities. However, our aim is not to model and test the classic conditional convergence but to focus on the role of space can generate increasing returns because of intra- and inter-spillovers in line with Fingleton (2001) and the reality in the UK of regional divide (see Gardiner et al., 2013 and McCann, 2020).

The inter-spillovers are captured by the last component in (2). $\prod_{j\neq i}^{N} \theta_{j,t}{}^{\xi w_{ij}}$ stands for neighbouring regions' productivity, where w_{ij} represents regional connectivity, indicating spatial externalities ($w_{ij} \in [0, 1]$, $\sum_{j\neq i}^{N} w_{ij} = 1$ if $i \neq j$ and $w_{ii} = 0$). N represents the total number of regions. ξ is the degree of technological interdependence, $\xi \in [0, 1)$. Presumably, ξ decays as regional connectivity gets weaker. Note that ξ can be 0, which suggests no inter-regional spillovers; otherwise, increases in physical and human capital or tourism in neighbouring regions can have an impact on region i. Take logs on both sides of (2) and rewrite it into matrix form:

$$\Theta = \bar{\Theta} + \alpha' K + \beta' H + \gamma' T + \xi W \Theta \quad (3)$$

where $\Theta_{N\times 1}$ is a vector of log regional productivity. $\bar{\Theta}_{N\times 1}$ is the log of region-specific productivity. $K_{N\times 1}$, $H_{N\times 1}$ and $T_{N\times 1}$ are vectors of log regional physical capital, human capital and tourism activities. $W_{N\times N}$ is the spatial weight matrix. If $\xi \neq 0$ and ξ^{-1} is not an eigenvalue of W, we can rearrange (3) to have:

$$\Theta = (I - \xi W)^{-1}\bar{\Theta} + \alpha'(I - \xi W)^{-1}K + \beta'(I - \xi W)^{-1}H + \gamma'(I - \xi W)^{-1}T \quad (4)$$

According to (4), region i's productivity accounting for both intra- and inter-regional externalities can be re-written as:

$$\theta_{i,t} = \bar{\theta}_i^{\frac{1}{1-\xi}} K_{i,t}^{\alpha'} H_{i,t}^{\beta'} T_{i,t}^{\gamma'} \prod_{j\neq i}^{N} K_{j,t}^{\alpha' \sum_{r=1}^{\infty} \xi^r w_{ij}^r} H_{j,t}^{\beta' \sum_{r=1}^{\infty} \xi^r w_{ij}^r} T_{j,t}^{\gamma' \sum_{r=1}^{\infty} \xi^r w_{ij}^r} \quad (5)$$

Plug (5) into (1), we have output per capita in region i written in spatial form:

$$y_{i,t} = \bar{\theta}_i^{\frac{1}{1-\xi}} K_{i,t}^{a_{ii}} H_{i,t}^{b_{ii}} T_{i,t}^{c_{ii}} \prod_{j\neq i}^{N} K_{j,t}^{a_{ij}} H_{j,t}^{b_{ij}} T_{j,t}^{c_{ij}} \quad (6)$$

where $a_{ii} = \alpha + \alpha'(1 + \sum_{r=1}^{\infty} \xi^r w_{ii}^r)$ and $a_{ij} = \alpha' \sum_{r=1}^{\infty} \xi^r w_{ij}^r$; $b_{ii} = \beta + \beta'(1 + \sum_{r=1}^{\infty} \xi^r w_{ii}^r)$ and $b_{ij} = \beta' \sum_{r=1}^{\infty} \xi^r w_{ij}^r$; $c_{ii} = \gamma + \gamma'(1 + \sum_{r=1}^{\infty} \xi^r w_{ii}^r)$ and $c_{ij} = \gamma' \sum_{r=1}^{\infty} \xi^r w_{ij}^r$. To save space, we do not provide more derivations.

Section D. Robustness checks

Table S4. Robustness check: different spatial weight matrices

Dep: Growth ($n = 133$)	2SLS ($k = 5$)					Two-step GMM ($k = 10$)				
Panel A	(1) Main	(2) WX	(3) Direct	(4) Indirect	(5) Total	(6) Main	(7) WX	(8) Direct	(9) Indirect	(10) Total
V_H	0.0641**	-0.2049***	0.0643***	0.0083	0.0726***	0.0230***	0.0827**	0.0297***	0.2212***	0.2509***
	(0.0132)	(0.0101)	(0.0131)	(0.0160)	(0.0159)	(0.0061)	(0.0126)	(0.0065)	(0.0394)	(0.0423)
$\hat{\rho}$	0.1638***					0.5787***				
	(0.0484)					(0.0280)				
Moran's *I* test	0.0327 (0.4890)					-0.0800 (0.8208)				
Panel B	2SLS ($k = 5$)					Two-step GMM ($k = 10$)				
V	0.0751***	-0.0418***	0.0744***	-0.0354**	0.0390**	0.0722***	-0.0202**	0.0849***	0.2028**	0.2877***
	(0.0134)	(0.0159)	(0.0132)	(0.0174)	(0.0166)	(0.0057)	(0.0105)	(0.0082)	(0.0828)	(0.0890)
$\hat{\rho}$	0.1474***					0.8194***				
	(0.0478)					(0.0252)				
Moran's *I* test	0.0348 (0.4580)					-0.1648 (0.7281)				
Panel C	Two-step GMM ($k = 7$)					Two-step GMM ($k = 7$)				
V_HP	0.1222***	-0.1300***	0.1159***	-0.1379***	-0.0219					
	(0.0064)	(0.0128)	(0.0068)	(0.0333)	(0.0363)					
V_MG						0.0109*	0.0296***	0.0153***	0.0968***	0.1121***
						(0.0057)	(0.0084)	(0.0059)	(0.0217)	(0.0235)
$\hat{\rho}$	0.6434***					0.6393***				
	(0.0269)					(0.0199)				
Moran's *I* test	-0.1158 (0.7771)					-0.1158 (0.7772)				
Panel D	2SLS ($k = 5$)					2SLS ($k = 10$)				
V_HP	0.1600**	-0.1233***	0.1578***	-0.1154***	0.0424*					
	(0.0177)	(0.0193)	(0.0176)	(0.0209)	(0.0233)					
V_MG						0.0076	0.0855***	0.0095	0.1162***	0.1257***
						(0.0126)	(0.0143)	(0.0124)	(0.0233)	(0.0213)
$\hat{\rho}$	0.1355***					0.2592***				
	(0.0470)					(0.0592)				
Moran's *I* test	0.0363 (0.4790)					-0.0169 (0.6810)				

Note: ***, ** and * denote 1%, 5% and 10% level of significance, respectively. Spatial HAC robust standard errors are reported in parentheses. For post-estimation tests, p-values are reported in parentheses. H_0 of Moran's *I* test is no spatial autocorrelation.

Table S5. Robustness check: partialling out the spatial distribution of attractions ($W: k = 7$)

Dep: Growth ($n = 133$)	2SLS					Two-step GMM				
Panel A	(1) Main	(2) WX	(3) Direct	(4) Indirect	(5) Total	(6) Main	(7) WX	(8) Direct	(9) Indirect	(10) Total
V_H	0.0254	0.5215***	0.1003***	1.622***	1.722***	0.0225***	0.1021***	0.0372***	0.3219***	0.3591***
	(0.0219)	(0.0306)	(0.0239)	(0.2344)	(0.2451)	(0.0077)	(0.0133)	(0.0091)	(0.0476)	(0.0543)
$\hat{\rho}$	0.6824***					0.6532***				
	(0.0398)					(0.0196)				
Moran's *I* test	-0.0117 (0.7960)					-0.1178 (0.7732)				
Panel B	2SLS					Two-step GMM				
V	0.1053***	0.3885***	0.1545***	1.1029***	1.2574***	0.0109	0.1165***	0.0255**	0.3223***	0.3478***
	(0.0236)	(0.0337)	(0.0244)	(0.1544)	(0.1626)	(0.0089)	(0.0161)	(0.0105)	(0.0522)	(0.0598)
$\hat{\rho}$	0.6072***					0.6337***				
	(0.0403)					(0.0206)				
Moran's *I* test	-0.0065 (0.8760)					-0.1162 (0.7763)				

Note: ***, ** and * denote 1%, 5% and 10% level of significance, respectively. Spatial HAC robust standard errors are reported in parentheses. For post-estimation tests, p-values are reported in parentheses. H_0 of Moran's *I* test is no spatial autocorrelation.