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Visitor flows to World Heritage Sites in the era of Instagram

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ABSTRACT

The aim of this study is to investigate the extent of visitors to World Heritage Sites in Europe and North America, given their specific location and characteristics. Visitor flows are approximated by 680 million Instagram posts for about 525 World Heritage Sites. Independent variables encompass year of inscription, size, type (monuments, churches, castles, architecture, industrial heritage, archaeological sites and cultural and natural landscapes), covered by the danger list, inclusion criteria and country of location. Results using robust regression and spatial lag models show that entire world heritage cities receive the highest number of Instagram posts while industrial heritage and prehistoric sites get the lowest number. The number of Instagram posts is significantly higher for the few World Heritage Sites included in the danger list and World Heritage Sites that are nominated in the early years of the programme.

1. Introduction

UNESCO World Heritage Sites (WHS) or other spectacular views are popular and often photographed by visitors and tourists (Leung et al., 2013). These days, a significant number of these visitors also upload their photos or videos to various online sharing platforms, such as Instagram, which was launched in 2010 (Miles, 2013). Photos not only document the tourist experience but may also shape it (Haldrup & Larsen, 2003; Larsen, 2008). Recently, researchers notice the so-called "Instagram Effect", which implies that a point-of-interest becomes increasingly popular by highlighting it on social media (Miller, 2017), independently of its capacity to absorb visitors. World heritage sites can also be icons of national identity (Shackley, 2006) and are thus increasingly used as tools for tourism marketing campaigns (Drost, 1996). This in combination with signs of strong growth in cities as well as in other areas with World Heritage Sites raises the discussion of over-visitation (Du Cros, 2008; Du Cros & Kong, 2020; Job et al., 2017; Larson & Poudyal, 2012; Milano et al., 2019; Orsi et al., 2020; Scuttari et al., 2019; Yang et al., 2019). Subsequently, there are suggestions that the social and environmental caring capacity of WHSs should be carefully defined, including an emphasis on information on visitor density (Kaltenborn et al., 2013; Megeirhi et al., 2020; Shelby, Vaske and Heberlein; 1989).

The aim of this study is to investigate the extent of visitors to World Heritage Sites in Europe and North America, given their specific location and characteristics. Visitor flows are approximated

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by the number of Instagram posts for each site, aggregated over the different hashtags available. Location and site specific independent variables in the robust regressions and spatial econometric models include: year of inscription, size (measured as land area in hectares), type (historical, monument, church, palace, castle, architecture, industrial heritage, archaeological or cultural landscape), covered by the danger list, inscription criteria and country of location. Data on visitor flows consist of approximately 680 million Instagram posts for 525 cultural and natural World Heritage Sites in early 2020. Information on the characteristics of the sites originates from UNESCO.

Understanding the popularity of cultural sites, national parks and other protected world heritage areas is crucial for their management and marketing. However, there are no overall measures of visitor density available, taking into account the specific characteristics and location of the WHS, neither based on data from UNESCO, nor from social media or other sources. A study in the vicinity of this is Levin et al. (2019), who use Flickr photos to explore the relationship between the popularity of World Heritage Sites and their risks of ending up on the danger list (and lose its assignment). Wuepper and Patry (2017) employ data from TripAdvisor on 319,000 World Heritage Sites visitors to investigate their awareness of the WHS logo.

In general, photos uploaded on social media sites are becoming an increasingly attractive source of information about number of visitors and visitor flows. They are used to model a) the relationship between social media activities and popularity of parks and recreational sites (Orsi & Geneletti, 2013; Sessions et al., 2016; Sinclair et al., 2020; Tenkanen et al., 2017; Wood et al., 2013), b) statistical relationships between tourism flows and geotagged tourist photography numbers at the city and regional level (Gunter & Önder, 2020; Kádár, 2014; Önder et al., 2016), c) tourism crowding based on information sourced from weibo (Chinese version of Twitter) (Shi et al., 2017), d) travel patterns of tourists using geotagged photos (Vu et al., 2015) and e) geotagged social media data from Twitter (Chua et al., 2016). Tenkanen et al. (2017) confirm that the number of Instagram posts for parks is a good approximation of official visitor statistics and thus reflect their popularity.

This study contributes a concise analysis of the extent of visitors to all North American and European World Heritage Sites independent of their location and characteristics. Most other studies are based either on traditional measures such as number of paying visitors or use photos originating from social media sites of specific destinations without considering other influencing factors or comparisons across different kinds of sites. Implicitly, the analysis also indicate to what extent big data can be used when consistent data sources on visitor flows are lacking.

The study is structured as follows. Section 2 introduces the conceptual background including the hypotheses and gives an overview of the literature, Section 3 presents the empirical model, while section 4 introduces the database and descriptive statistics. Section 5 provides the empirical results, and Section 6 concludes.

2. Conceptual background and hypotheses

Present study uses the concepts of visitor or tourist carrying capacity of parks or sites as a theoretical starting point (Manning, 2013; McCool & Lime, 2001). The carrying capacity can be defined in different ways (McCool & Lime, 2001), with visitor density, that is, the number of visitors in a given area being a common measure (Shelby et al., 1989). This measure can also be related to the desired or accepted level of visitors (Jacobsen et al., 2019). Building further on this starting point, identification of social media induced tourism (Shin & Xiang, 2020) and the concept of user generated content as well as digital word of mouth (Bronner & De Hoog, 2011) are crucial. According to Akehurst (2009), the credibility of user generated digital content sources are trustworthy. As opposed to traditional sources, Instagram is a channel with power to shape the (digitally guided) image of a destination or cultural site, with attractive or popular sites receiving more contributions. There are also no lead times, once shared or uploaded, the image is available to all. Unlike Twitter and Facebook, Instagram

cannot create text-only content. This "picture first, text second" rule of Instagram creates a strong visually oriented culture (Lee et al., 2015).

By expanding the concept of visitor density (Shelby et al., 1989, for instance), this study allows an overall assessment of World Heritages Sites independent of their specific locations and characteristics. The basic idea is to use the number of Instagram posts as an approximation for the extent of visitors. While visitor density might be a relatively neutral term, crowding is commonly used as the negative evaluation of a certain density, a value judgement that indicates that there are too many people (Graefe et al., 1984). However, as shown for the Yosemite National Park World Heritage Site, there is not always a clear correlation between visitor density and perceptions of crowding (Absher & Lee, 1981). The tourism literature has long developed so-called visitor or tourism intensity indices. Harrison (1992) introduces the "tourism intensity rate", which is measured as the number of visitors per 1,000 inhabitants and per square kilometre of total or arable land. De Albuquerque and McElroy (1992) extend this indicator to account for the length of stay and De Ruyck et al. (1997) measure visitor density of beaches.

Since World Heritage Sites are magnets for visitors (Fyall & Rakic, 2006), they tend to experience positive as well as negative impacts (Adie, 2019; Frey & Steiner, 2011; McKercher & Du Cros, 2002; Rasoolimanesh et al., 2017). It is regularly argued that high numbers of visitors to some World Heritage Sites also may lead to their deterioration (Frey & Steiner, 2011). Nevertheless, the negative effects must be confronted with the positive ones. Adie and Hall (2017) demonstrate that visitors to World Heritage sites tend to be highly educated, indicating higher average spending at the destination. Similar findings are reported for a sample of visitors to George Town WHS by Rasoolimanesh et al. (2017).

The number of visitors is usually measured by paid entrants or with the help of sensors. A growing number of studies examine if photos shared on social media platforms are good indicators of visitor flows. Wood et al. (2013), for example, show that photos on Flickr explain more than a third of the variation in visitor flows for 836 recreational sites around the world, while Sessions et al. (2016) demonstrate that the quantity of photos taken in a park reliably indicates the number of visitors in a given month. Similarly, several other studies use Flickr photos as indicators of visitation (Crandall et al., 2009; Levin et al., 2015). For instance, Levin et al. (2015) show that UNESCO World Heritage sites receive higher visitation as measured by Flickr photos per unit area, compared to all other types of protected areas. There is also an increasing literature that identify popular sites in urban areas using information from social media (García-Palomares et al., 2015; Kádár, 2014), as well as to identify lodging locations (Sun et al., 2013).

Tenkanen et al. (2017) document that the monthly visitor patterns based on social media websites correspond relatively well with the official visitor numbers of the natural park. The authors also report significant differences between the platforms, with Instagram performing better than Twitter and Flickr. This relationship can also be expected for cultural sites such as historical monuments, palaces and churches, which makes good pictures, often in combination with the visitors themselves.

Instagram based information is increasingly used to investigate the attraction factors of national parks for tourists (Hausmann et al., 2017), rural areas (Varnajot, 2019) or tourist attractions in cities (Gunter & Önder, 2020), although Tenkanen et al. (2017) as well as Ghermandi and Sinclair (2019) suggest that Instagram remains a relatively unexplored source of data for research, even if it has been gaining momentum recently. However, there are no studies that explicitly focus on the popularity of cultural sites in social media platforms and their determinants. In addition, few studies investigate potential visitor density of tourist attractions in cities based on social media. An exception is Shi et al. (2017), who use information from Weibo to explore the tourist crowding in Shanghai. With almost half a million observations available, the authors identify the most popular urban tourist attractions and factors related to tourist crowding.

The literature on and measurement of visitors to World Heritage Sites are straying in several directions. This is no surprise due to their different locations, characteristics and confinements. Some of them are well fenced-off, while others simply cannot be separated from their

surrounding areas. Because of this, the theoretical underpinning of a comparable analysis of a large group of sites cannot rely on absolute numbers of visitors or visitors per area. Instead, the number of visitors needs to be modelled as a function of typical site and location specific characteristics. In the absence of actual data for several sites, the number of Instagram posts is used as an approximation for the extent of visitors. In the following, the main variables reflecting location and characteristics are extracted from the literature.

Previous research show that inclusion in the UNESCO list has a significant impact on tourism (Buckley, 2004 for natural WHS, Yang et al., 2010 for cultural and natural sites) although recent studies are more sceptical to this tourism enhancing effect (Cellini, 2011; Cuccia et al., 2016; Jones et al., 2017). A meta-analysis finds that the UNESCO World Heritage listing has no impact on tourism demand at all (Yang et al., 2019). Levin et al. (2019) suggest that the WHS inscription is a useful branding tool that can help to raise funding. Related to this is also the year in which the World Heritage title was awarded. Those early assigned are likely to receive a large number of Instagram posts. The reason for this is that they are already commercialised and presumably better known to potential tourists and visitors. Examples of early nominations are the national parks in the United States (Everglades National Park, Grand Canyon National Park, Yellowstone National Park, all inscribed before 1980) or in Europe (Plitvice Lakes National Park in 1979), the historical cities in Europe (Historic Centre of Kraków, Historic Centre of Rome and Old City of Dubrovnik, all before 1980) or masterpieces of historical sites (Independence Hall in 1979). World Heritage Sites that are designated at a later date are not always equally known to a wider audience and it takes time before they receive more attention. Thus, the first hypothesis can be formulated:

H1: The number of Instagram posts is related to the age of inscription as a World Heritage Site.

Another factor which is important is the size of the World Heritage Site. A large site, such as an entire city, a cultural landscape or natural park, can accommodate more visitors and thus receive more Instagram posts than a single historical monument or church. An empirical question is whether the relationship is disproportional, that is, if the number of Instagram pictures grows less than proportionally with size.

H2: The number of Instagram posts of a World Heritage Site is related to its size.

Besides inscription year and size, kind of WHS is also relevant (Wuepper & Patry, 2017). World Heritage Sites are heterogeneous and include both cultural and natural sites. Cultural sites sometimes encompass entire cities or large landscapes and in other cases smaller places such as palaces, churches and industrial plants. Entire cities or historical parts of a city may have many cultural sites and therefore receive more photos than a single world heritage site. Examples are Paris, Prague, Rome, Saint Petersburg, Budapest, Istanbul, Edinburgh, Florence and Vienna with numerous cultural and historical sites, not seldom regarded as masterpieces. On the other hand, sites of industrial heritage and mining areas, for instance, might be less noticed by the typical tourist and more by groups with specific interests.

H3: The number of Instagram posts of World Heritage Sites varies by kind.

It is commonly argued that high number of visitors to some World Heritage Sites may lead to their deterioration (Frey & Steiner, 2011). This stands in conflict to the protection of cultural heritages. There is a list of World Heritage Sites in Danger (Frey & Steiner, 2011). Possible reasons for ending up on this list include physical deterioration, large-scale public or private development projects, threats of an armed conflict, calamities and cataclysms (UNESCO 1972: Article 11§4 cited in Brown et al., 2019). Common threats identified are management and institutional factors (e.g., lack of financial resources, legal protection, management plans), followed by buildings and development, other human activities (e.g., civil unrest, war, illegal activities), and social/cultural uses of heritage (e.g., tourism, changes in local lifeways, social cohesion) (Boniface, 2001; Brodie & Renfrew, 2005; Brown et al., 2019; Buckley, 2018; Larson and Poudyal, 2012; Levin et al., 2019; Osti et al., 2011; Veillon, 2014).

However, being on the danger list is not in itself a factor that stirs demand for the WHS, instead it is expected to reflect a particular type of sites, assumedly very old and well-established long before inscription to the UNESCO programme. Examples of this are the Everglades National Park, the Old City of Dubrovnik, the Plitvice Lakes National Park and the Yellowstone National Park (https://whc.unesco.org/en/danger/). Only 15 of the 53 World Heritage Sites on the Danger can be found in Europe or North America.

H4: The number of Instagram posts are related to World Heritage Sites listed as being in danger.

Besides these four hypotheses, a set of control variables are also included. According to UNESCO, there are six criteria for cultural sites and four for natural sites (http://whc.unesco.org/en/criteria/). Nominated sites must meet at least one of the 10 criteria and are applied in conjunction with three comprehensive aspects: uniqueness, historical authenticity and integrity (Wuepper & Patry, 2017). If a site meets at least one cultural and one natural criterion, the property is classified as a mixed site (Frey & Steiner, 2011). Another control factor that could affect the number of Instagram posts is the attractiveness of a neighbouring World Heritage Site. In Europe, such sites are not always far apart, examples are Colosseum and Forum Romanum in Rome, Italy, where agglomeration effects might appear (Wuepper & Patry, 2017; Yang & Fik, 2014). The country itself where the site is located may also play a role in the attractiveness.

3. Empirical model

Given the conceptual and theoretical considerations, the extent of visitors, here approximated by the (logarithm of) the number of Instagram posts of World Heritage Sites in early 2020, $ln(INSTAGRAMPOSTS)$ is expected to depend on several site and location specific factors including agglomeration (Wuepper & Patry, 2017; Yang & Fik, 2014):

$$ln(INSTAGRAMPOSTS)_i$$

$$= \beta_0 + \beta_1 Age_i + \beta_2 \ln(Size)_i + \sum_{n=1}^{8} \beta_{3n} Type_{in} + \beta_4 Dangerlist_i + \sum_{c=1}^{9} \beta_{5c} Criteria_{ic}$$

$$+ \sum_{co=1}^{26} \beta_{6co} Country_{ico} + \rho W \ln(INSTAGRAMPOSTS)_i + \varepsilon_i. \tag{1}$$

Subscript i denotes the World Heritage Site, c is country, ε_i reflects the error term, β_0 is the constant and $ln()$ is the natural logarithm. *Age* measures the number of years from inscription until 2020 and *Size* denotes the area of the World Heritage Site in hectares excluding the wider zone. Variable *Type* illustrates the kind of site by a set of eight dummy variables: (i) historical city, (ii) church or related site, (iii) archaeological site, (iv) cultural landscape, (v) historical site, (vi) industrial heritage, (vii) prehistoric site and (viii) natural World Heritage Sites with other world heritages as a reference group. *Dangerlist* is a dummy variable equal to one if the site is listed as being in danger. *Criteria* is another dummy variable based on the conditions for becoming a World Heritage Site (aspects such as uniqueness, historical authenticity and integrity) and *Country* controls for country specific factors such as size. This latter set of dummy variables also encompasses WHSs that crosses national borders (transboundary). The spatially lagged log number of the Instagram posts, $Wln(INSTAGRAMPOSTS)$ is the weighted number of Instagram posts of the surrounding sites with W being the spatial weight matrix. The coefficients are represented by β_1 to β_6 and ρ is the spatial lag parameter. When the size of the World Heritage Site is controlled for, coefficients, β_1 and β_3 to β_6 can be interpreted as relationships with visitor density.

Since the left-hand variable may encompass outliers and extreme observations, robust regression methods as well as median regressions are used instead of Ordinary Least Squares (OLS) (Huber,

1964; Rousseeuw & Leroy, 2003). It is known that OLS is sensitive to influential observations and outliers. To allow for a non-linear relationship between the number of Instagram posts on the one hand and size as well as age on the other, their respective squared terms are tested.

4. Data and descriptive statistics

Data is retrieved during March 2020 and originates from the UNESCO World Heritage database and the Instagram website (www.instagram.com). The Convention concerning the Protection of the World Cultural and Natural Heritage entered into force in 1977 and is ratified by almost all countries in the world (https://whc.unesco.org/en/statesparties/) . The full list of World Heritage Sites is downloaded from https://whc.unesco.org/en/list/, and the List of World Heritage Sites in Danger is retrieved from https://whc.unesco.org/en/danger/. Included in the World Heritage data-base are information on the name, date inscribed, longitude, latitude, area in hectares, criteria (C1, C2, C3, C4, C5, C6, N7, N8, N9 and N10), category (cultural, natural and mixed) and country. As the number of mixed sites is only two per cent, these are assigned to natural heritage sites. The Hierapolis-Pamukkale and the Historic Sanctuary of Machu Picchu are examples of a mixed heritage site. The world heritage site list comprises 1121 objects of which those 525 located in Europe or North America are used for the empirical analysis.

The dependent variable, number of Instagram posts reflecting the extent of tourists, is col-lected by using information on the number of posted hashtags related to World Heritage Sites. Manikonda et al. (2014) note that users of Instagram often use hashtags while posting pictures to get more followers. Therefore, the hashtags are suitable for counting the number of posts on a certain object. Subsequently, the number of posts is calculated based on several different hash-tags for each site. To avoid double counting, cross-postings from other social media platforms are not included (Rogers et al., 2017). A variation of names or languages on hashtags are com-monly used to define the same locations. An example of this is the world heritage site of the old town of Dubvronik: #dubrovnik; #dubrovnikoldtown; #dubrovnikcroatia; #visitdubrovnik. Other examples are the posts for the World Heritage Site of the Amiens cathedral: #Amienscathedral; #Cathedralamiens; #Amienscathedrale; #cathedraleamiens; #cathédraleamiens; or Historic Centre of Saint Petersburg and Related Groups of Monuments#санктпетербург, #stpetersburg and #sanktpetersburg. Because of this, hashtags with English as well as national languages are used in the analysis.

The data retrieving method used leads to a base of 680 million Instagram posts from approxi-mately 1500 hashtags on 525 World Heritage Sites. An alternative way to create the database could have been to use geotagged photos. However, this would have vastly reduced the number of sites and posts possible to include in the analysis since the majority of Instagram photos are not geotagged (Boy & Uitermark, 2017).

Earlier research indicates that persons who upload photos to the Internet tend to be younger, better educated and earn a higher income than those who do not (Lo et al., 2011). The European household survey of ICT usage and e-commerce activities in 2019 verifies this claim. Social media networks usage (such as Twitter, Facebook etc.) is highest among young people aged 16-34 (88 per cent) (Source: Eurostat, 2020, https://ec.europa.eu/eurostat/databrowser/view/isoc_ci_ac_i/default/table?lang=en, accessed 10 November 2020), although more than every second individual aged between 45 and 54 years is also a user. Persons in the age group 65-74 years old are the least frequent social media users (21 per cent). Although many Instagram posts, the usage patterns of different age groups mean that it is not entirely clear whether the results of this study can be generalised also for older persons.

There are various ways to define the spatial weight matrix (Anselin, 2013). In this case, the exponential decay function based on geographical distance is used to calculate the weights. This
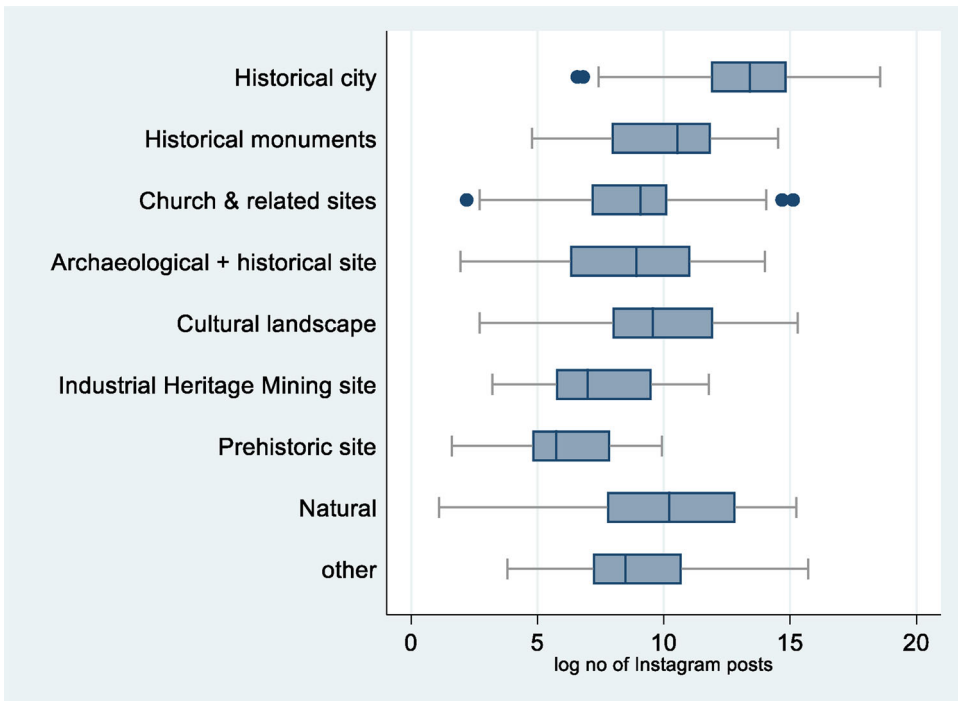
Figure 1. Number of Instagram posts by kind.
Source: Instagram, accessed March 2020, and own calculations.

means that the geographical distance between two pairs of sites is calculated using their longitude and latitude positions.

The average number of Instagram posts is approximately 20,000 and the mean size of a site is 200 hectares (Table 2). On average, the WHS is 22 years old and Italy hosts nine per cent of all sites in Europe and North America. Three per cent of the WHSs are included in the danger list. The attractiveness of World Heritage Sites by type is unevenly distributed (Figure 1). Among the eight types, historical cities is the largest group and represents one fifth of all sites investigated. Prehistoric sites is the smallest group (Duval & Smith, 2013). Also, World Heritage sites that have been included in the List of Danger attract more Instagram posts (Figure 2).

Paris, Istanbul and Rome have the largest amount of posts for cultural world heritage cities (between 50 and 110 million posts). Notre Dame in Paris is the predominant historical site with 3.7 million posts, followed by the Vatican City (2.4 million posts). The Acropolis in Athens is the most popular archaeological site in this respect. At the lower end of the scale are several churches, monuments, industrial heritages or mining sites in rural areas with less than 100 posts each. Sites in Austria, Italy and Russia meet the largest amount of Instagram attention (Figure 3). According to the criteria, World Heritage Sites that are assessed as representing a masterpiece of human creative genius and cultural significance (C1) get the utmost attention as well as the fourth criteria for natural WHSs (as the most important and significant natural habitats for in-situ conservation of biological diversity) (Table 1, Figure 4).

The correlation between the number of posts and the time since inscription of the WHS is significant and shows that the older the WHS, the more attention it receives (Figure 5). In fact, the size variable correlates with the number of posts for three out of six different kinds of sites (Figure 6). Overall, the descriptive statistics show that the number of Instagram posts of World Heritage Sites varies broadly across type, country, age, size and inclusion in the danger list.
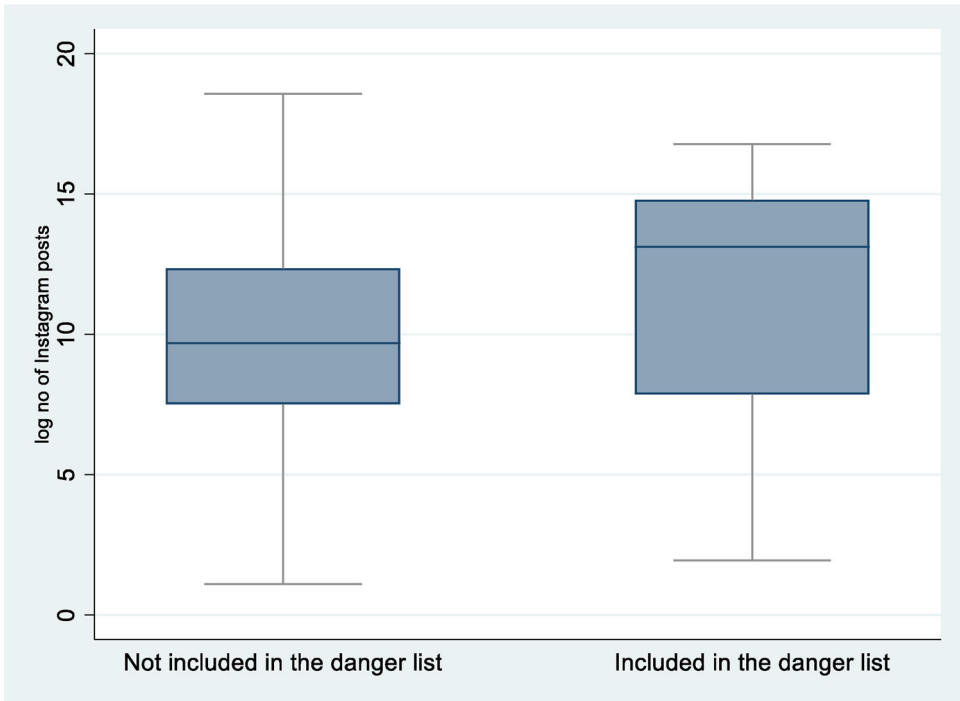
Figure 2. Average number of Instagram posts by site on the danger list.
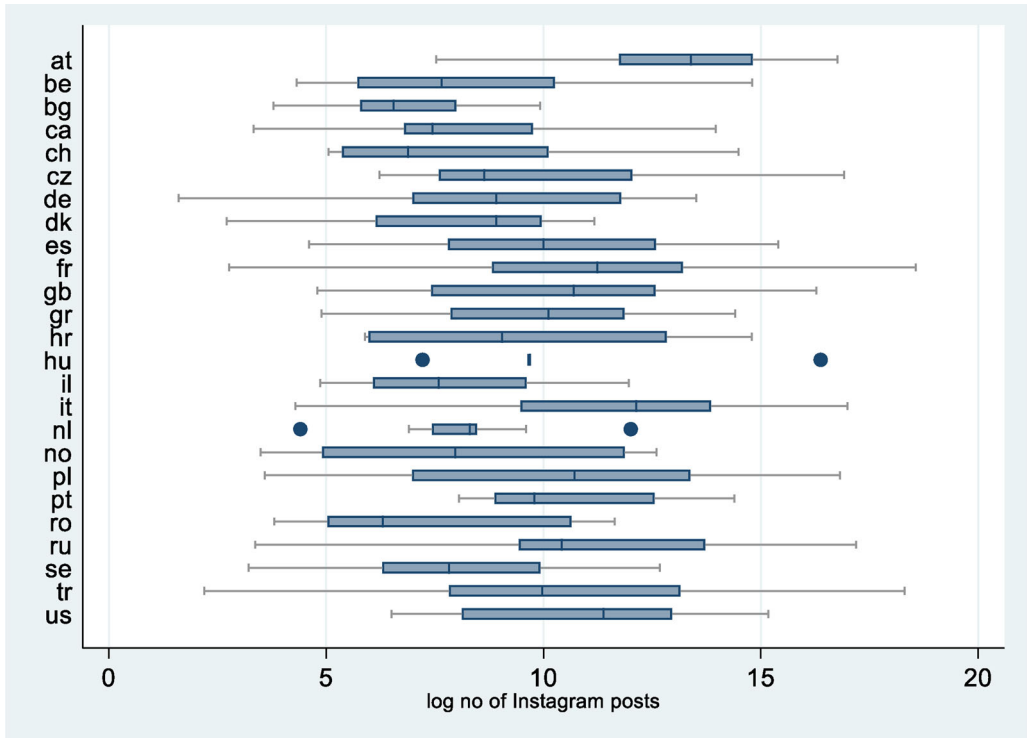Source: Instagram, accessed March 2020, and own calculations.

Figure 3. Average number of Instagram posts by country.
Notes: The left axis contains the ISO 2 country codes.
Source: Instagram, accessed March 2020, and own calculations.

Table 1. Number of Instagram posts by type (top 5) (in 1000 s).

Historical cities		Cultural Landscape	
Paris, Banks of the Seine	115400.0	Costiera Amalfitana	4398.3
Historic Areas of Istanbul	89809.4	The Climats, terroirs of Burgundy	3056.5
Historic Centre of Rome, the Properties	53417.9	The English Lake District	2642.5
Historic Centre of Saint Petersburg	29402.5	Cultural Landscape of Sintra	1774.9
Venice and its Lagoon	23950.7	Royal Botanic Gardens, Kew	576.3
Historical monuments		**Industrial heritage and mining sites**	
Statue of Liberty	2019.6	Mines of Rammelsberg	131.7
Palace and Park of Versailles	1895.1	Saltaire	75.4
Alhambra, Generalife and Albayzín, Granada	1543.3	Zollverein Coal Mine Industrial Complex	43.8
Historic Monuments of Novgorod and Surro	913.3	Heritage of Mercury. Almadén and Idrija	38.4
Tower of London	619.4	Wieliczka and Bochnia Royal Salt Mines	24.8
Churches		**Natural sites**	
Cathedral of Notre-Dame	3684.9	The Dolomites	4199.4
Vatican City	2382.6	Grand Canyon National Park	3905.6
Churches of the Pskov School of Architecture	1263.7	Yosemite National Park	2908.2
Cathedral of St Peter and Church of Our Lady in Trier	536.9	Golden Mountains of Altai	2234.1
Assisi, the Basilica of San Francesco	522.8	Yellowstone National Park	2169.4
Archaeological sites		**Prehistoric Sites and caves**	
Acropolis, Athens	1213.1	Rock Carvings in Tanum	20.6
Cilento and Vallo di Diano National Park	1104.8	Heart of Neolithic Orkney	13.2
Syracuse and the Rocky Necropolis of Pan	1101.3	Prehistoric Sites; Decorated Caves of the Vézère Valley	8.6
Paphos	982.2	Decorated Cave of Pont d'Arc	2.6
Stonehenge, Avebury and Associated Sites	717.0	Madara Rider	0.5

Source: Instagram, accessed March 2020, and own calculations.
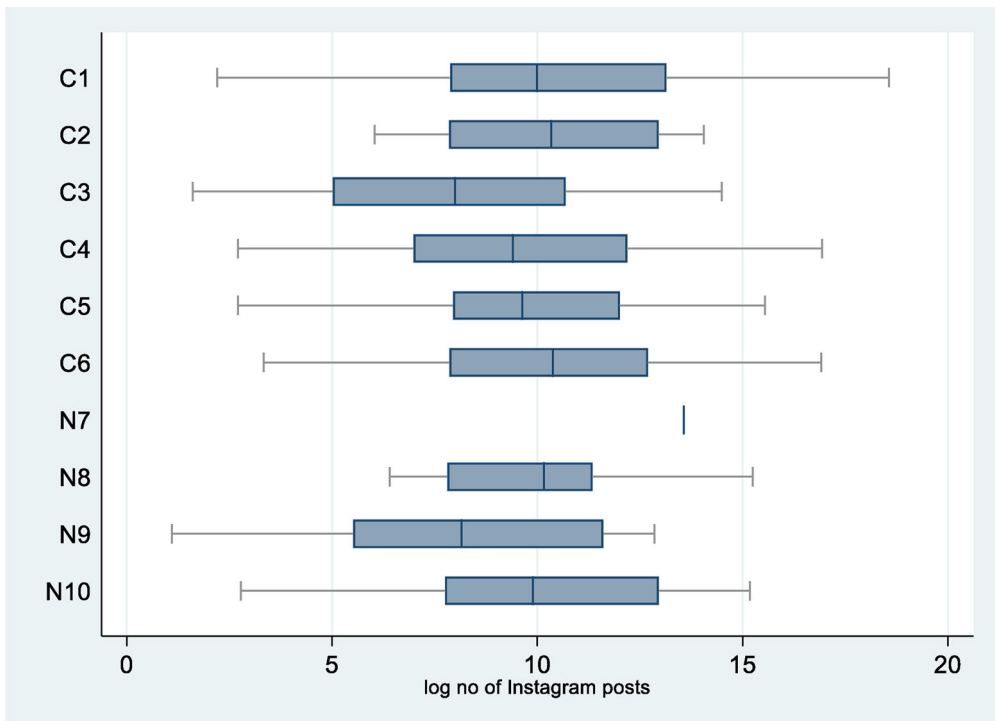
Figure 4. Average number of Instagram posts by criteria.
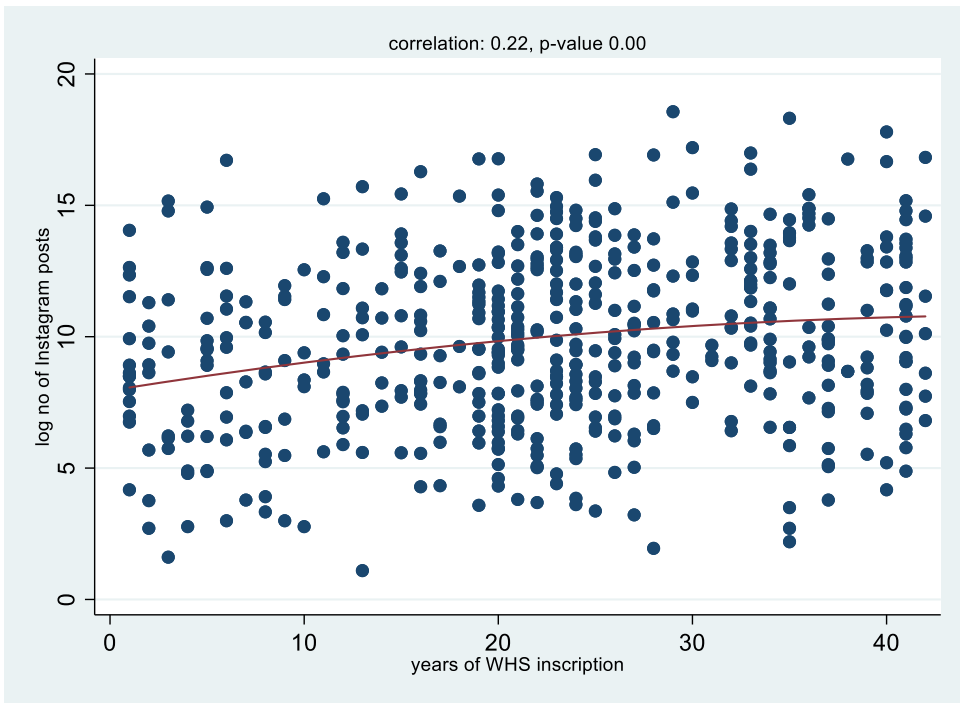Source: Instagram, accessed March 2020, and own calculations.

Figure 5. Relationship between the number of Instagram posts and years of inscription of the WHS.
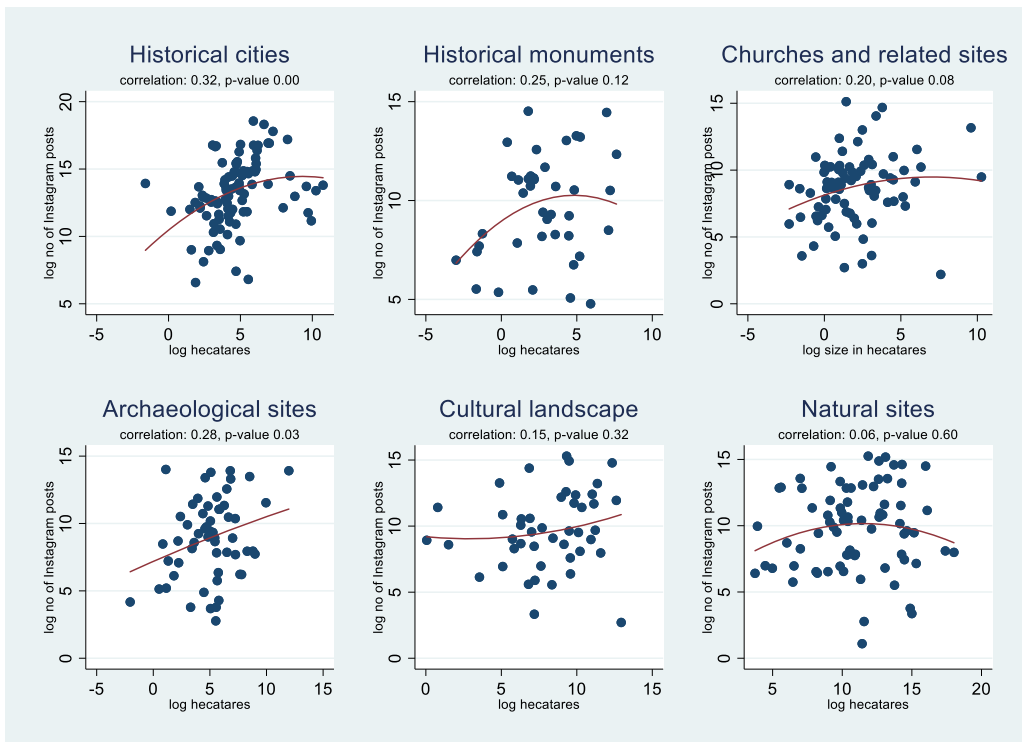Source: WHS database, Instagram, accessed March 2020, and own calculations.

Figure 6. Relationship between the number of Instagram posts and size by type.
Source: UNESCO World Heritage Site database and Instagram.

Table 2. Descriptive statistics.

	Mean	Std. Dev.	Min	Max
Ln Instagram posts	9.9	3.3	1.1	18.6
Spatial lag of ln Instagram posts (exponential decay function)	10.0	3.1	2.0	18.6
Spatial lag of ln Instagram posts (power functional type)	10.1	3.2	1.9	18.6
Ln area, hectares	5.3	4.0	−4.9	18.0
Age of inscription of WHS (years)	22.8	11.2	1.0	42.0
Dummy variables:		Per cent		Per cent
Location (ISO two-digit country code)				
AT	1.3	Assignment to danger list	2.9	
BE	1.9	Type:		
BG	1.7	Historical city	19.8	
CA	3.4	Historical monument	9.1	
CH	1.5	Church or related site	17.5	
CZ	2.5	Archaeological site	12.0	
DE	7.4	Cultural landscape	9.0	
DK	1.7	Industrial heritage	5.3	
ES	8.0	Prehistoric site	2.7	
FR	7.8	Natural WHS	14.9	
UK	5.9	Other WHS	9.7	
GR	3.4	Criteria:		
HR	1.3	Criteria cultural WHS 2	46.3	
HU	1.1	Criteria cultural WHS 6	19.0	
IL	1.7			
IT	9.3			
NL	1.7			
NO	1.3			
PL	2.5			
PT	3.0			
RO	1.3			
RU	4.8			
SE	2.5			
TR	3.4			
US	4.2			
Transboundary	4.6			
Other countries	10.5			

Source: World heritage site database. Instagram, own calculations (accessed March 2020).

5. Empirical results

Robust regressions show that the number of years since inscription, size, kind of WHS, inclusion in the danger list, evaluation criteria and location are all factors of significance for the extent of visitors to World Heritage Sites (Table 3). The relationship between the number of Instagram posts and size of the WHS shows a non-linear inverted u-shaped pattern, where the number of posts increases until the turning point of 160,000 hectares and then decreases. However, this turning point is very high, above the 90 percentile of the size variable, implying that a positive relationship dominates (Figure 7). The average marginal effect of size is 0.15 which means that an increase of 10 per cent is associated with a surge of 1.5 per cent in the number of Instagram posts.

Number of years since inscription and size of the World Heritage Site are the two continuous variables and they are of equal importance. An increase in the number of years since the inscription of the WHS by one standard deviation (from the sample mean of 23 to 34 years) is associated with a 56 percent change in the number of Instagram posts. World Heritage Sites that are one standard deviation larger (10710 hectares as compared to the sample mean of 205 hectares) have 55 per cent more Instagram posts, ceteris paribus.

Among the dummy variables, the strength of the relationship is most pronounced for the WHSs listed as being in danger. These sites receive four times more Instagram posts than those that are not listed (($\exp(1.66)-1$)*$100 = 4.3$), thus a somewhat counter-productive results. It is, however, important to note that the danger list itself is barely a factor of attractiveness, rather it

Table 3. Determinants of the number of Instagram posts of World Heritage Sites.

	(i) Robust regression		(ii) Robust regression		(iii) OLS		(iv) Median regression	
	coeff.	t-stat	coeff.	t-stat	coeff.	t-stat	coeff.	t-stat
Spatial lag of Ln Instagram posts	0.04	0.89						
Ln area, hectares	0.28 ***	3.46	0.28 ***	3.49	0.25 ***	3.52	0.31 ***	3.27
Ln hectares squared	−0.01 *	−1.93	−0.01 *	−1.93	−0.01 **	−2.12	−0.02 **	−2.40
Age of inscription of WHS	0.05 ***	4.36	0.05 ***	4.44	0.05 ***	4.29	0.05 ***	3.45
Assignment to danger list	1.62 **	2.32	1.66 **	2.37	1.36 *	1.65	1.83 **	2.17
Type (ref cat.: other)								
Historical city	3.76 ***	7.91	3.71 ***	7.79	3.59 ***	7.24	4.22 ***	7.35
Historical monument	0.91 *	1.70	0.93 *	1.73	0.69	1.26	1.19 *	1.84
Church or related site	−0.07	−0.14	−0.13	−0.26	−0.32	−0.61	0.14	0.23
Archaeological site	−0.50	−0.93	−0.51	−0.95	−0.68	−1.14	−0.04	−0.06
Cultural landscape	0.54	0.96	0.50	0.89	0.45	0.76	1.46 **	2.16
Industrial heritage	−1.71 ***	−2.77	−1.72 ***	−2.78	−1.72 ***	−2.97	−1.60 **	−2.14
Prehistoric site	−2.59 ***	−3.26	−2.65 ***	−3.32	−2.71 ***	−3.16	−1.98 **	−2.06
Natural WHS	0.73	1.21	0.59	0.98	0.46	0.68	1.59 **	2.20
Criteria cultural WHS 2	0.70 ***	2.69	0.71 ***	2.74	0.72 ***	2.85	0.93 ***	2.94
Criteria cultural WHS 6	0.84 ***	2.82	0.85 ***	2.84	0.84 ***	2.66	0.94 ***	2.60
Country dummies (ISO 2 digit)								
AT (other)	1.23	1.19	1.35	1.31	1.48 **	2.01	1.32	1.07
BE	0.04	0.04	−0.05	−0.06	−0.04	−0.05	0.39	0.36
BG	−1.79 *	−1.91	−1.84 **	−1.96	−1.85 **	−2.29	−1.54	−1.37
CA	−1.38 *	−1.93	−1.40 *	−1.95	−1.27 *	−1.84	−1.51 *	−1.75
CH	−0.84	−0.88	−0.79	−0.82	−0.64	−0.67	−1.10	−0.94
CZ	−0.20	−0.25	−0.22	−0.28	−0.33	−0.43	0.56	0.58
DE	0.24	0.44	0.23	0.43	0.23	0.44	0.47	0.72
DK	0.37	0.40	0.31	0.34	0.04	0.04	0.95	0.85
ES	0.37	0.70	0.39	0.74	0.41	0.83	0.42	0.67
FR	1.35 **	2.50	1.41 ***	2.62	1.29 **	2.22	1.61 **	2.48
UK	1.30 **	2.16	1.19 **	2.01	0.92	1.37	1.47 **	2.07
GR	0.61	0.84	0.58	0.80	0.77	1.18	0.29	0.33
HR	−0.68	−0.66	−0.66	−0.64	−0.56	−0.79	−0.52	−0.42
HU	0.40	0.36	0.46	0.42	0.50	0.60	0.53	0.40
IL	0.00	−0.01	−0.06	−0.07	0.01	0.01	0.48	0.43
IT	1.66 ***	3.17	1.76 ***	3.44	1.75 ***	3.34	1.78 ***	2.89
NL	0.01	0.01	−0.06	−0.07	−0.06	−0.08	−0.21	−0.18
NO	−0.91	−0.88	−0.94	−0.91	−0.67	−0.74	−1.14	−0.91
PL	0.87	1.10	0.91	1.16	0.89	1.27	1.33	1.39
PT	0.91	1.26	0.97	1.34	1.01 *	1.73	1.64 *	1.88
RO	−1.07	−1.04	−1.14	−1.11	−1.06	−1.19	−0.82	−0.67
RU	2.10 ***	3.21	2.21 ***	3.39	2.02 ***	2.88	2.27 ***	2.89
SE	−0.75	−0.94	−0.80	−1.00	−0.73	−0.97	−0.14	−0.15
TR	1.87 ***	2.62	1.92 ***	2.69	1.04	1.05	1.95 **	2.26
US	1.24 *	1.81	1.31 *	1.92	1.48 **	2.10	1.74 **	2.12
Transboundary	0.94	1.44	0.98	1.51	0.95	1.32	1.36 *	1.74
Constant	5.69 ***	8.18	6.03 ***	10.17	6.24 ***	10.02	5.39 ***	7.54
Average marginal effect of size	0.15 ***	3.54	0.15 ***	3.50	0.13 ***	3.00	0.13 **	2.43
Number of observations	525		525		525		525	
Adjusted R^2/Pseudo R^2					0.475		0.323	

Notes: Asterisks ***, ** and * denote significance at the 1, 5 and 10 per cent levels. The dependent variable is the logarithm of the number of Instagram posts.

illustrates a specific cultural landmark, well-established long before the UNESCO appeared with its label. Kind of site is also relevant, entire WHS cities like Paris, Istanbul, Rome and Venice receive a number of Instagram posts amounting to a factor 40 higher than that of others (such as churches, archaeological sites and the remaining category). Industrial heritages, including mining and prehistoric sites meet the lowest number of Instagram posts, ceteris paribus. Among the assignment criteria," WHS represents an important interchange of human values on developments in architecture or technology, monumental arts, town-planning, or landscape design") and "WHS is associated with events, living traditions, ideas, beliefs, artistic and literary works of
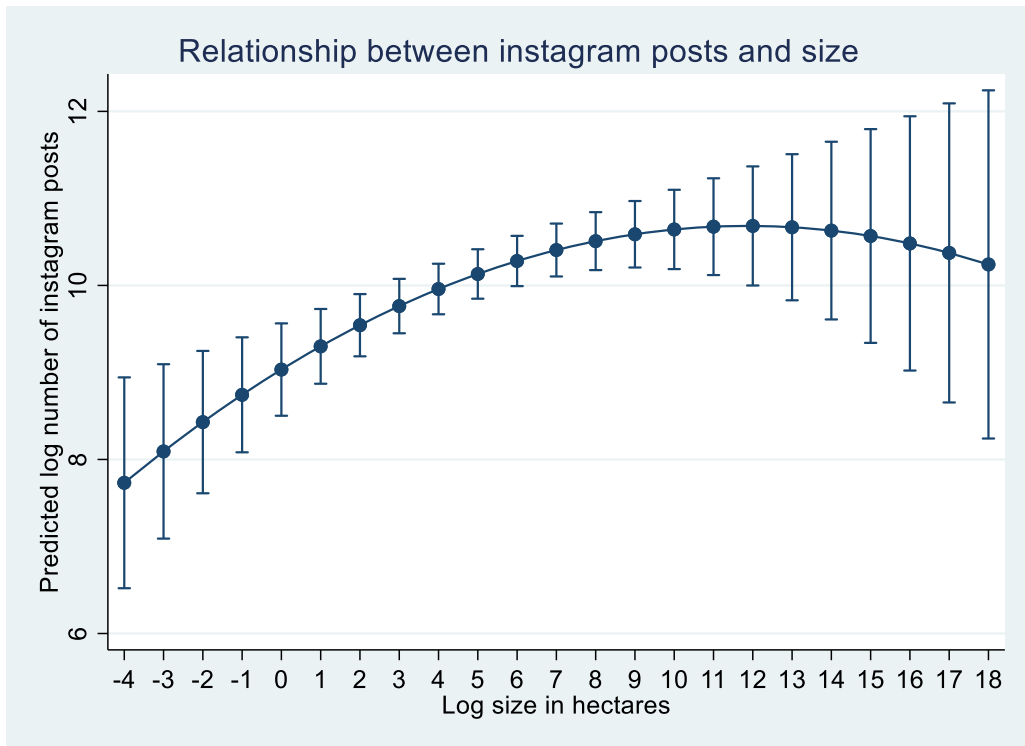
Figure 7. Relationship between the number of Instagram posts and size.
Notes: The predicted logarithm of Instagram posts is calculated using the delta method using the estimates for size and size squared in specification (i) shown in Table 3.
Source: Instagram, accessed March 2020, and own calculations.

outstanding universal significance" are highly significant. Overall, none of the four hypotheses can be rejected at the five percent level.

World Heritage Sites in classic tourism destination countries such as France, Italy, Turkey United Kingdom and United States, as well as in Russia, receive attention aplenty. The latter demonstrates the highest number of Instagram posts, ceteris paribus. This is possibly related to a large domestic market, stipulated by many hashtags in different local languages. Finally, the spatial variable is not significantly different from zero, indicating that the attractiveness of the neighbouring World Heritage Sites is not relevant for the number of Instagram posts.

There are no similar studies investigating the visitor flows to all World heritage Sites within a certain geographic area by use of Instagram data together with site and location specific characteristic, implying that it is difficult to compare with earlier literature. However, as Kim et al. (2019), Tenkanen et al. (2017) and Wood et al. (2013) show, social media data appear to be useful for this type of analyses. The results also highlight the built-in contradiction of being listed as a WHS: a site that needs to be protected from deterioration at the same time as the label itself is an automatic marketing tool (Adie et al., 2018; Frey & Steiner, 2011).

Other research suggests careful visitor management by for instance reduction of traffic (Scuttari et al., 2019). Typically, this is customised rather than general measures for natural sites and landscapes, most likely also very costly. Protective measures cannot be seen as one-sided, they require not only investments on the part of cultural sites and local governments but also a more environmentally conscious behaviour by visitors (Buonincontri et al., 2017; Ramkissoon et al., 2018). Thus, the responsibility of the latter could for instance include avoiding visiting sites during peak times, high seasons or when the level of other heavily negative aspects affect the site.

Several robustness checks are carried out. Firstly, the inclusion of age squared in the regressions renders small estimates that do not significantly improve the fit of the model. Secondly, separate regressions are performed for historical cities since the number of Instagram posts may be a misleading indicator of visitors to urban areas. Unreported results show that the sign and meaning are quite similar. Thirdly, alternative regression methods are used to verify that the results do not vary due to the choice of estimator (Table 3, Specifications iii and iv for OLS and median regressions). More advanced robust regression techniques are also tested such as the efficient MM-estimator (Rousseeuw & Leroy, 2003). The results are not sensitive to this and are available upon request.

6. Conclusion

This study investigates the extent of visitors to World Heritage Sites in Europe and North America, given their specific locations and characteristics. Visitor flows are approximated by 680 million Instagram posts for about 525 World Heritage Sites. Results of robust regressions show that the number of Instagram posts is significantly higher for World Heritage Sites that are large and those that were inscribed early. In addition, the kind of site is also important, most pronounced by the "cultural city", while industrial heritage and pre-historic sites are far less popular. The relationship between number of Instagram posts and size increases until a threshold is reached and then decreases. There are also variations across countries, where sites located in main tourist countries such as Italy, France, United Kingdom and Turkey are more popular.

Sites that are included in the UNESCO danger list, that is, those who risk losing their label are also strongly related to the number of Instagram posts. This is a somewhat contra-productive result that highlights the contradictions of being inscribed as a World Heritage Site. On the one hand it is a measure of protection, on the other it is an excellent marketing channel. Keeping a balance between these two aspects may be particularly difficult for sites well-established long before the UNESCO programme without physical boundaries or those without a clear management structure.

Theoretically, the study broadens the concept of visitor density to become generic by using social media data and by taking the specific locations and characteristics of World Heritage Sites into account. This type of indicators can be used by managers for benchmarking purposes across sites. The number of social media posts of World Heritage Sites may also be used as forecasts of future visitor flows, implying that that these sources are important for managers to regularly follow.

Other practical implications are that well-known, and long-since established cultural sites and cities tend to get a high level of attraction. These sites may therefore be at risk of being over-visited. This is particularly problematic for cultural cities, since they usually do not have any physical boundaries or fees that facilitates the management of large groups of visitors. An increasing number of photographs of previously relatively unknown sites can also stimulate the interest of potential visitors to a level that the site does not manage. Compared with the past with travel books and reports, information on sites is now available instantaneously, allowing no time for adjustment.

The finding that industrial heritage sites are less popular than cultural cities and monuments suggests that the latter no longer need to be marketed. However, it also gives strong signals to the less visited sites to prepare for changes in the visitor flows and to formulate strategies to meet risks of over-visitation or over-exploitation.

Some limitations need to be noted. Previous research indicates that those who upload pictures to the internet are younger, better educated and have incomes higher than average. This means that older individuals may be somewhat underrepresented in this study, although this is not possible to verify with present data, a situation not uncommon when big data is used. To overcome such problems, large scale cross-country surveys or, preferably, harmonised official statistics need to be used. There might also be some differences in the propensity to upload pictures on the internet across countries. Second, the results only hold for World

Heritage Sites in developed countries (Europe and North America). The majority of sites that are included in the danger list are located in war zones or in developing countries.

There are several ideas for future work. First, the geographical scope of the analysis can be extended to sites in other parts of the world. Second, the analysis can be broadened by collecting information for Instagram sites over time. It is expected that the Covid-19 pandemic will lead to new challenges in managing the number of visitors to certain sites.

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