Annals of Tourism Research 68 (2018) 20–29

Contents lists available at ScienceDirect

Annals of Tourism Research

journal homepage: www.elsevier.com/locate/annals

# Tourism in Iceland: Persistence and seasonality

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ARTICLE INFO

*JEL classification:*
C22
L83

*Keywords:*
Iceland
Tourism time series
Long memory
Persistence
Policy

ABSTRACT

This paper analyses tourism in Iceland using fractional integration and taking into account the seasonality and the degree of persistence in the data. Using annual data, the unit root hypothesis cannot be rejected, implying permanency of shocks. However using, monthly data, a break is found at 2009m7 and the orders of integration are in the interval (0, 0,5) suggesting mean reversion. The conclusion is that exogenous shocks impacting inbound tourism do not persist and tend to disappear relatively fast. The key policy implications thereof are reported at the end of the paper, critiquing the classical response to perceived slumps in inbound tourism that include marketing and promotion instead of developing infrastructure in anticipation of resumed growth in inbound tourism.

## Introduction

This paper analyses the development of the Icelandic tourism sector through inbound tourism statistics as compiled by the Icelandic Tourist Board. The data is analysed using time series techniques based on the concept of fractional integration or I(d) behaviour, which allows for an investigation into the degree of persistence in the data. By persistence we mean the level of association between the observations. The higher the level of association between observed points in the time series the higher is the dependence between them in the data. Understanding data persistency contributes to the formation of tourism policy as the severity and persistence of a downturn in inbound tourism numbers can be forecasted. Being able to foresee if trends persist and to what degree will inform tourism policy. Slumps in inbound tourism can thus be tackled with appropriate policy measures, such as boosting transport link development or planning and funding a marketing strategy if the slump is likely to persist, or boosting domestic product development and infrastructure investment if it will not and growth resumes relatively quickly.

The fractional integration approach is chosen specifically as it seems to be more flexible than other more classical methods that are based either on stationary models or nonstationary ones, or more specifically on I(0) and I(1) models respectively.[2] By using fractional integration, the order of integration of the series is permitted a fractional value, which may be constrained between 0 and 1 or even above 1 depending on the degree of persistence of the data. This is important because in the event of an exogenous shock, such as natural catastrophes, terrorism, pandemics or economic downturns, the fractional value can give information about the duration or how shock induced setbacks will impact the projected future development of the series. Thus, if a series is I(d) with $d < 1$, shocks will have a transitory nature, with their effects disappearing in the long run, and at a faster rate the lower the value of

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1 Prof. Luis A. Gil-Alana gratefully acknowledges financial support from the Ministerio de Economia y Competitividad (ECO2014-55236). Comments from the Editor and two anonymous reviewers are gratefully acknowledged.

2 An I(0) process is defined as a covariance stationary process where the infinite sum of the autocovariances is finite. It thus includes the white noise case but also weakly autocorrelated structures like the stationary ARMA ones. On the other hand, a process is I(1) if it requires first differences to render the process I(0).

https://doi.org/10.1016/j.annals.2017.11.002
Received 11 May 2017; Received in revised form 29 October 2017; Accepted 1 November 2017
0160-7383/ 

d is, requiring inward facing policy measures of e.g. preparing for the trend resumption. On the other hand, if a series is I(d ≥ 1) shocks will have a permanent nature, requiring outward, i.e. marketing and access oriented policy measures to recover the original long term projections.

We focus on Iceland because as other Nordic countries it has experienced a continuous increase in the number of visitors for the last three decades (Hall, Müller, & Saarinen, 2009). However, unlike Northern European and other Nordic destinations, the island nation of 340,000 has witnessed an almost exponential growth in inbound tourism since 2010. In 2017 up to 2.5 million guest are expected, up from around 490,000 in 2009 and 2010. This rapid growth has sparked concerns about which particular exogenous shocks could impact the growth of inbound tourism and how these could persist. The paper's research question is: what is the degree of persistence of exogenous shocks in the existing data on inbound tourism to Iceland? In other words, if in the event of a negative exogenous shock to the tourism sector in Iceland, to what extent will the inbound tourism trend recover by itself in the long run with no need of outward oriented policy actions. Analysing two sets of time series from 1949 till 2016, the impact of former exogenous shocks and their persistence can be established. Using fractional integration it can be shown that shocks can be long-lived persisting forever (if d ≥ 1) or disappearing though very slowly (if d is large though smaller than 1). As stated, the lower the value of this integration, the faster the recovery process will be. In the empirical application carried out in Section '*Empirical results*' different hypotheses concerning the order of integration of the Icelandic inbound tourism series are tested, including the classical ones based on integer differentiation such as I(1) and I(2) behaviour but also others based on fractional values such as those based on long memory (d > 0), stationarity (d < 0.5) or mean reverting (d < 1) behaviour.

## Contextual setting

Exogenous shocks that can impact the tourism industry are divided by Henderson (2007) into eight categories. Macroeconomic fluctuations impacting demand, political turmoil at a destination level, global terrorism threat levels, socio-cultural conflicts, environmental issues, pandemics, technological failure, and commercial setbacks. All eight can in one way or another have ramifications for inbound tourism development globally or at a given destination. The paper's focus on Iceland relies on the fact that the development of tourism in Iceland has experiences sustained growth throughout the post-war years. However, in the last decade this development has been extremely rapid, driven by nigh on exponential growth in inbound tourism, mainly from Europe and North America, even though three exogenous shocks can be identified that typically thwart tourism growth. Chief amongst these is the extreme strength of the króna in the year leading up the financial collapse of the island in 2008. This placed Icelandic tourism at a distinct disadvantage as a prohibitively pricey destination in comparison to neighbouring destinations. The second is the global economic downturn that precipitated the krónas collapse but at the same time sent inbound tourism worldwide in a downward spiral. Thirdly is the natural catastrophe of the Eyjafjalljökull eruption which upset aviation globally and smothered large tracks of land under ash. Despite this tourism has grown as Table 1 shows, citing some of the key indicators of inbound tourism growth.

The year 2009 is selected as a reference as the take-off in inbound tourism can be tagged to the year 2010. Still prior to that, ever since 1990 Iceland had seen a healthy growth in inbound tourism numbers exceeding that of most competing destinations in the region. Secondly, what is intriguing is the fact that this growth has continued more or less unabated since the 1970s, with few very minor setbacks.

The take-off in 2010 can be attributed to several well-documented factors, mostly substantiated in outbound tourism surveys performed by the Icelandic Tourist Board. The primary one is the growth of awareness concerning Iceland, although this is of-course hard to measure and tally. The absolute collapse of the island's financial sector, with huge socio-economic ramifications made it to the world's headlines. Iceland was the first victim of the global credit crunch, which sparked a pronounced tourism slump all over the world, especially in long-haul destinations. Iceland, however held on in terms of inbound tourism, not least due to the spring 2010 eruption of Eyjafjallajökull even though it created a temporary setback in inbound tourism for the month the eruption lasted (Jóhannesson & Huijbens, 2010). The May eruption sent clouds of ash over key hubs in West Europe effectively grounding air traffic for up to a week with global ramifications (Budd, Griggs, Howarth, & Ison, 2011). People across the planet were stuck in airports from Dubai to Singapore, Buenos Aires to Los Angeles. When the global media explained what was going on, the limelight was squarely cast on the sparsely populated, volcanic, sub-Arctic island in the North Atlantic recently having been claimed by the global credit crunch. The image of the North, and Iceland in particular, has been traditionally associated with harsh climate, hardy people and as a place where one can come up close and personal to the elements (Ísleifsson & Chartier, 2011). The global media lime-light most certainly perpetuated these tropes in its coverage of the collapse of the financial sector and the volcanic outburst. Marauding financial Vikings from a desolate wilderness island at the edge of the habitable world, underlined in the minds of those wanting to come into

**Table 1**
Key indicators of tourism growth in Iceland.

| Source | Indicator | 2009 | 2016 | Growth % |
|---|---|---|---|---|
| Iceland Tourist Board | Departing foreign nationals counted at KEF international | 464.536 | 1767.726 | 281% |
| Statistics Iceland | Foreigners' bednights in all accommodation establishments | 2134.245 | 6764.615 | 217% |
| Statistics Iceland | TSA inbound tourism expenditure calculations | 92,3 bISK | 357 bISK | 287% |
| Keflavík International Airport | Total number of pax at KEF international airport | 1832.944 | 6821.358 | 272% |
| Icelandair | Total number of passengers carried by the airline | 1319.207 | 3674.592 | 179% |

intimate contact with the forces of nature why they should go to Iceland and for those not wanting to do so, why they should not come. Iceland thus emerged as a travel option in the minds of travellers around the world to a much greater extent than ever before. These are travellers with ever-increasing means and opportunities to travel (UNWTO, 2016).

Generally increasing levels of global travel and the search for ever more exotic destinations is most certainly a factor contributing to the post 2010 explosive growth of inbound tourism to Iceland. But global travel also revolves around access, over and above consumer awareness. Therein air connectivity and aviation industry development play a key role. Deregulation and the introduction of open-skies agreements in the 1990s has resulted in the growth of global aviation and increasing competition with lowering prices, although other factors have produced varying "shades" of this increase (Christidis, 2016). The International Air Transport Association predicts that passenger numbers are set to double between 2016 and 2035 (IATA, 2016). Icelandic airlines have utilized every aspect of deregulation, chief amongst them is the quasi legacy carrier Icelandair. Operating the first low-cost *trans*-Atlantic flights in 1953, curtesy of bi-lateral aviation agreements with Luxembourg and the US, this airline has built an extensive network linking North America to Europe for the last 65 years. Their hub is the old US naval base at Keflavík, Iceland built during the Second World War by the US navy as part of its mission to maintain the occupation of Iceland and secure northern Atlantic air routes. The base was operated from 1951 till 2006. The Icelandic government opened a passenger terminal at the base in 1987, but the base itself is currently used by the Icelandic Coast Guard. When awareness of Iceland and its destination qualities became global, infrastructure was in place and aviation routes already well established. Getting there was easy from the heartlands of international tourism in North and West Europe and N. America. Now, following the massive growth of inbound tourism, another Icelandic low cost carrier Wow air, is emulating Icelandair's hub and spoke model and in summer 2017 a total of 26 operating carriers will fly into Keflavík, up from 17 in summer 2011. This ever increasing ease of access has greatly facilitated the tourism boom Iceland is now witnessing, and has prompted the Icelandic aviation authority (ISAVIA) to further invest in Keflavík airport (ISAVIA, 2015). In a newly conceived masterplan by ISAVIA, traffic through the airport is meant to triple before 2040, precipitating the growth of an Aerotropolis (Kasarda, 2011) in its environs, aspiring to become for the North Atlantic, what Dubai is for the Middle East (RÚV, 2016). Thus airlines are being actively solicited to come to the island though ISAVIA incentives, such as lowering air passenger duties during off-peak hours at the terminal (Mbl, 2017), further contributing to the growth of inbound tourism.

A third factor that contributed to this massive growth is the devaluing of the Icelandic currency in the wake of the 2008 financial collapse. The ISK exchange rate index (turned narrow trade index in 2009) hit an all-time high 1st December 2008 at 249, up from a low of 99 in November 2005. After the initial drop in value in the wake of the October 2008 financial collapse the ISK has been inching its way towards its former strength and as currency restrictions were lifted in March 2017 the index stands at around 155 (Central Bank of Iceland, 2017). This devaluing compounded with ever cheaper airfares in an increasingly more competitive global aviation market, made it cheaper for people to travel to Iceland and stay there.

Lastly, what is worth mentioning in explaining the nigh on exponential growth of inbound tourism in Iceland, is the fact that in the wake of the Eyjafjallajökull eruption the government and the tourism industry joined hands in the biggest ever marketing campaign for Icelandic tourism: Inspired by Iceland. Originally fuelled by concerns that the eruption would halt all inbound tourism to the country, the marketing strategy was focused on perpetuating the message that Iceland was a safe place to go to despite the eruption. This campaign soon morphed into a general marketing campaign utilising newly conceived social media strategies and facilitating C2C marketing and communication (Promote Iceland, 2017). The Inspired by Iceland campaign was successful in bringing together industry stakeholders and the public sector and has produced innovative advertisements that have caught the attention of the international advertising and marketing community. Together with marketing strategies of Icelandair (see e.g. Icelandair, 2016) they have successfully sustained the awareness created by the eruption and, as such, contributed to the growth of inbound tourism.

Currently however, concerns within the industry are starting to manifest in terms of which exogenous shocks might impact the growth of tourism and how these will persist. These concerns are also fuelled by historical hindsight, as the traditionally resource dependent economy of Iceland has suffered boom-bust cycles before precipitated by exogenous shocks. The "herring adventure" in the 50s and 60s resulted in the annihilation of the Norwegian-Icelandic herring stock partly due to ocean circulation changes, resulting in industry collapse to the severe detriment of many settlements (Arnason, 1995). Experiments with fur production and fish farming collapsed as markets collapsed with the growth of animal welfare concerns in the case of fur, and disease racked havoc in fish monocultures in the latter case. Both had enjoyed a period of over investment and high expectations. The Icelandic banking and finance sector had a short period of spectacular growth, reaching almost 10 times the Icelandic GDP and then suffered an absolute collapse in autumn 2008 with the onset of the global credit crunch (Einarsson et al., 2015). The tourism industry thus has some reason for concern.

The exogenous influence sparking those concerns at current, over and above the traditional exogenous impacts affecting any tourism destination are mainly two amongst the Travel Industry Association (SAF) and public sector policy makers, both reflecting political turmoil at a destination level and socio-cultural conflicts (Henderson, 2007). One has to do with the strength of the króna. The currency is as of March 2017 re-floated on international currency markets. With the growth of inbound tourism the Central Bank's currency reserves are swelling, leading to the strengthening of the króna. In that sense a perceived exogenous shock to tourism is inbound tourism itself.

The second concern has to do with current proposals by the government to place all travel services under full VAT taxation at 22,5% (up from 11%) in July 2018. This has sparked concerns over major ramifications on inbound tourism induced by the inevitable price increases resulting from the tax hike. Moreover, the slow, but steady strengthening of the currency, mainly due to inbound tourism, adds to the perceived price increases in Iceland. The current concern is that these shocks will result in Iceland pricing itself out of the global tourism market and seriously hampering its global competitiveness (SAF, 2017).

Inbound tourism in Iceland has grown extremely rapidly after 2010. The main factors explaining this explosive growth, is the by

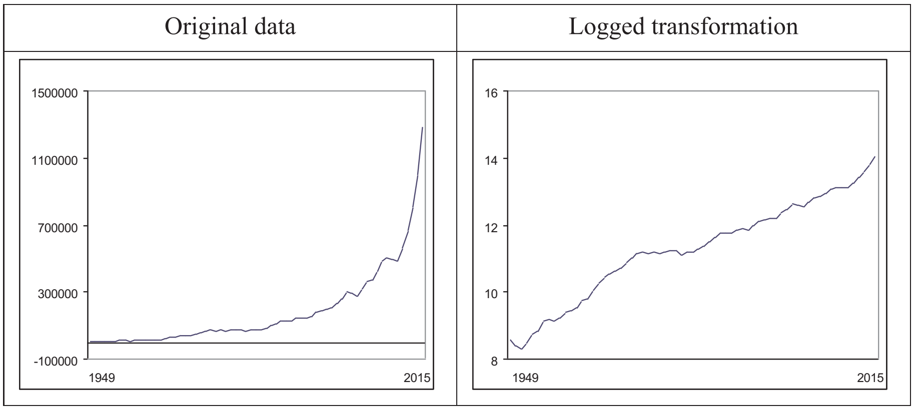


**Fig. 1.** Annual data: Foreign visitor arrivals by air and sea to Iceland.

now global awareness of the destination and its qualities, solid transport links and price. The perceived threats to this growth at current revolve around taxing policy and macro-economic currency fluctuations. Both are potential exogenous shocks to inbound tourism, but the question is if there is cause for concern about their long term impact on inbound tourism?

## Data and methodology

To understand tourism development in Iceland as manifest in the inbound tourism statistics compiled by the Iceland Tourist Board, series based on two different frequencies were used: annual and monthly. For the annual data the number of foreign visitor arrivals by air and sea to Iceland from 1949 to 2015 were used. Prior to 2002 these were compiled by the Immigration authorities, but thereafter by the Icelandic Tourist Board. For the monthly data, the number of visitors to Iceland through Keflavik airport from January 2003 to December 2016 were used. The data source is the Icelandic Tourist Board visitor Departure Statistics, but all passengers leaving the country through Keflavík showing a foreign passport are counted and registered as tourists. This results in a slight skewness of the data, i.e. inbound tourism is overestimated by 4–6% on average (Frent, 2013, p.80).

Fig. 1 displays the original annual data and its log transformation. A continuous increase in the original data can be observed; it starts increasing further in the 70s and the highest increase is observed during the last 15 years. As expected, the log-transformation shows a smoother behaviour.

The monthly data are displayed in Fig. 2 and seasonality becomes an issue in both the original and the log-transformed data. In order to remove the seasonality, two approaches are considered. First, the monthly averaged values were removed from the original data, and second, seasonal first differences were taken on the log-transformed data. The deseasonalized series are presented in Fig. 3.

To establish the persistence of shocks in the data series of Icelandic inbound tourism, techniques based on long-range dependence or long memory processes were used. Fractional integration model was chosen within this category, which basically means that the number of differences required to render a series stationary I(0) might not necessarily be an integer value, usually 1, but a fractional one, constrained between 0 or 1 or even above 1. Using a mathematical notation, a time series $\{y_t, t = 1, 2, \ldots\}$ is integrated of order d, and denoted as I(d), if it can be represented as

$$(1-L)^d x_t = u_t, \quad t = 1,2,\ldots, \tag{1}$$

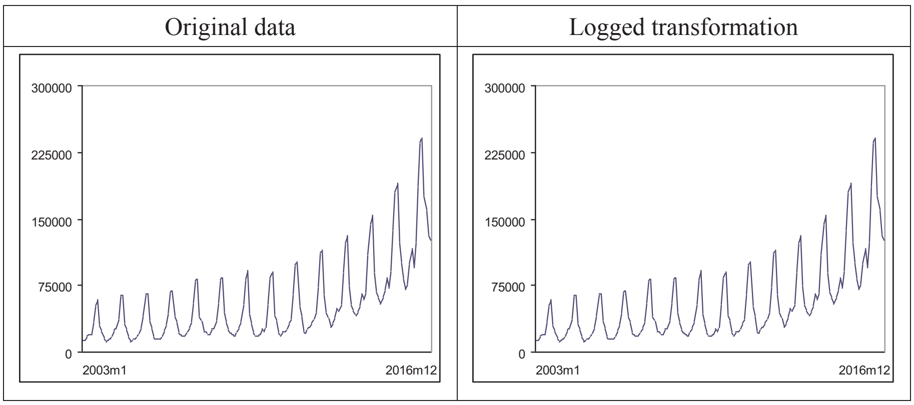


**Fig. 2.** Monthly data: Visitors to Iceland through Keflavik airport.

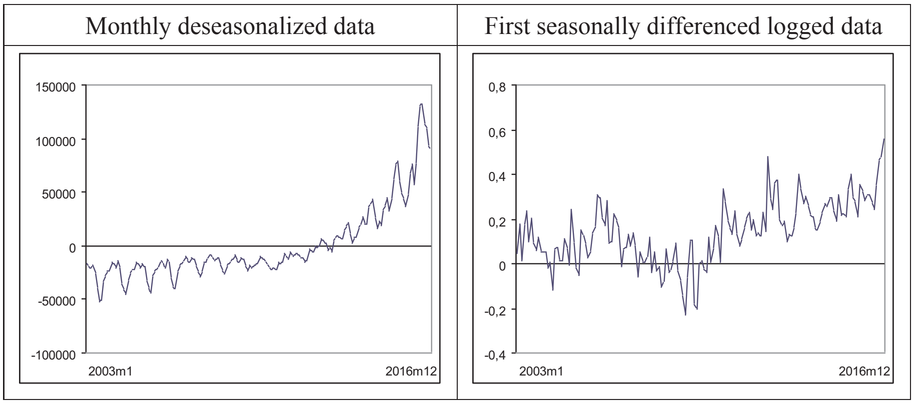


**Fig. 3.** Monthly data: Visitors to Iceland through Keflavik airport (seasonal mean subtracted).

where L means the lag operator (i.e., $Lx_t = x_{t-1}$), d can be any real value, and $u_t$ is an error term that is supposed to be well behaved and integrated of order (I(0)). Clearly, if d in Eq. (1) is an integer value, i.e., 1 or 2, $x_t$ will be a function of its previous value ($x_t = x_{t-1} + u_t$) or a function of $x_{t-1}$ and $x_{t-2}$ ($x_t = 2x_{t-1} - x_{t-2} + u_t$), respectively. However, if d is fractional, the following Binomial expansion needs to be used,

$$(1-L)^d = \sum_{j=0}^{\infty} \binom{d}{j} (-1)^j L^j = 1 - dL + \frac{d(d-1)}{2} L^2 - \frac{d(d-1)(d-2)}{6} L^2 + ...,$$

and thus,

$$(1-L)^d x_t = x_t - dx_{t-1} + \frac{d(d-1)}{2} x_{t-2} - \frac{d(d-1)(d-2)}{6} x_{t-3} + ...$$

so that Eq. (1) can be expressed as

$$x_t = dx_{t-1} - \frac{d(d-1)}{2} x_{t-2} + \frac{d(d-1)(d-2)}{6} x_{t-3} - ... + u_t.$$

In other words, $x_t$ will be a function of all its past history, and the higher the value of d, the higher is the level of association between observations distant in time. Processes with $d > 0$ in (1) display the property of "*long memory*", so-named because of the strong association between observations distant in time, and characterised because the autocorrelations decay hyperbolically slowly and the spectral density function is unbounded at the origin. These processes were introduced in the 80s by Granger (1980), Granger and Joyeux (1980) and Hosking (1981), but became popular in economics in the late 90s and 2000s (see, e.g. Baillie, 1996; Gil-Alana & Robinson, 1997; Andersen & Bollerslev, 1998; Michelacci & Zaffaroni, 2000; Barkoulas & Baum, 2006). Applications in tourism time series include the papers by Gil-Alana (2005), Chu (2008), Chokethaworn, Sriboonjit, Chaiboonsri, and Chaitip (2010), Assaf, Barros, and Gil-Alana (2011, 2012), Gil-Alana, Perez de Gracia, and Mudida (2016), Al-Shboul and Anwar (2017), among many others.

The main advantage of the fractional integration models is that they allow for a greater degree of flexibility in the dynamic specification of an analysed series, not restricted to the cases of stationarity I(0) or non-stationarity I(1). This has an important implication in terms of the persistence of possible shocks. Thus, under the I(0) specification (i.e., d = 0), shocks disappear relatively fast, just the contrary to what happens in the I(1) model where shocks have a permanent nature, persisting forever, and requiring strong measures to recover the original trends. In the I(d) case, shocks can persist albeit with non-permanent effects, and the lower the value of d is, the faster the convergence process with the observed trends will be (See Gil-Alana & Hualde, 2009, for an overview of the empirical literature on I(d) models). Based on this more flexible approach and its inherent long memory property, these type of models may also be more appropriate than other models in predicting the long-term evolution of the data.

## Empirical results

Starting with the annual data, and based on the increasing trend observed in Fig. 1, the first thing to consider is the following linear regression model:

$$y_t = \alpha + \beta\, t + x_t\,, \quad t = 1,2,..., \tag{2}$$

where $y_t$ is the original series (number of visitors in Iceland), and taking into account the potential long memory nature of the data, the error term $x_t$ is assumed given by Eq. (1). Thus, under the null hypothesis that the order of integration of the series is $d_o$, that is,

$$H_o\!: d = d_o, \tag{3}$$

where $d_o$ can be any real value, the null model becomes:

**Table 2**
Estimation of d based on annual data.

| *i) Original data* | | | |
|---|---|---|---|
| | No regressors | An intercept | A linear time trend |
| White noise | 2.24 (1.98, 2.56) | 2.23 (1.97, 2.55) | 2.23 (1.97, 2.55) |
| Autocorrelation | 1.44 (0.66, 2.35) | 1.46 (0.62, 2.39) | 1.33 (0.75, 2.37) |
| | d | Intercept coefficient | Trend coefficient |
| White noise | 2.24 (1.98, 2.56) | ——— | ——— |
| Autocorrelation | 1.33 (0.75, 2.37) | -7721.6616 (-2.27) | 24034.7402 (2.03) |
| *ii) Logged transformation* | | | |
| | No regressors | An intercept | A linear time trend |
| White noise | 0.95 (0.79, 1.16) | 1.20 (0.90, 1.50) | 1.15 (0.95, 1.46) |
| Autocorrelation | 0.89 (0.57, 1.29) | 0.64 (0.49, 1.43) | 0.77 (0.53, 1.17) |
| | d | Intercept coefficient | Trend coefficient |
| White noise | 1.15 (0.95, 1.46) | 8.52894 (89.12) | 0.08350 (4.01) |
| **Autocorrelation** | **0.77 (0.53, 1.17)** | **8.45022 (78.64)** | **0.08124 (13.93)** |

In bold the selected model according to various diagnostic tests. In parenthesis the 95% confidence band for the values of d and the t-values for the corresponding intercept and time trend coefficients.

$$y_t = \alpha + \beta\, t + x_t; \quad (1-L)^{d_o} x_t = u_t\ ; \quad t = 1,2,..., \tag{4}$$

and the differencing parameter $d_o$, is estimated along with the other parameters in the model (namely, α and β), under the two cases of uncorrelated (white noise) and autocorrelated errors. In the latter case, a non-parametric specification with reference to Bloomfield (1973) is used so as to produce autocorrelations decaying exponentially fast as in the ARMA case.[3]

The numbers reported across the tables refer to the estimates of d based on the data, noting that d describes the degree of dependence/persistence in the data. These values have been obtained using Robinson's (1994) method and choosing the value of $d_o$ in (3) that produce the lowest statistic. This method is a Lagrange Multiplier (LM) test that uses the Whittle function in the frequency domain and that has several advantages with respect to other methods. Thus, for example, it remains valid in nonstationary ($d_o \geq 0.5$) contexts with no need of differentiation, and its limiting distribution is standard normal; moreover, this standard asymptotic behaviour holds independently of the inclusion of deterministic terms and of the way of modelling the I(0) error term.

Across Table 2 the results for the three standard cases examined are displayed in the unit roots literature, i.e., the case of no deterministic terms (α = β = 0 *a priori* in Eq. (4)), an intercept (α unknown, and β = 0 *a priori*), and an intercept with a linear time trend (α and β unknown).

The first thing to be observed in Table 2 is that for the original data (Table 2i), the estimated values of d are extremely large, especially in the white noise case, ranging from 1.97 to 2.56. Thus, the confidence intervals include the value of 2 in all cases, implying that the I(2) hypothesis cannot be rejected; however, imposing autocorrelated disturbances, the values are smaller, though the confidence bands are still extremely wide, including both the I(1) and the I(2) hypotheses. Using log-transformed data, Table 2ii), the values are now smaller and the I(1) or unit root hypothesis cannot be rejected in any of the two cases of uncorrelated and autocorrelated errors. Moreover, the time trend seems to be required, and using some diagnostic tests on the residuals,[4] the selected model seems to be the autocorrelated one, with an order of integration of 0.77, and a corresponding confidence interval of (0.53, 1.17). As a conclusion in this table, evidence of I(1) behaviour and persistency of the shocks is shown, requiring strong measures in the event of a negative shock to recover the original trend (See Fig. 4 for the estimated trend function).[5]

As expected, seasonality becomes a relevant issue in the monthly data (Fig. 2). Table 3 displays the monthly averages in both the original and the log-transformed data, with the highest values being obtained in the months of July and August. As mentioned earlier, two approaches were used to remove the seasonal component. First the series were deseasonalized by subtracting the averaged monthly values, and as an alternative approach, seasonal (monthly) first differences were taken.

In Table 4 the estimates of the coefficients of the same model as before are displayed (Eq. (4)) but, taking into account the seasonal nature of the series, the error term now follows a seasonal AR(1) process of the following form:

$$u_t = \phi u_{t-12} + u_t\ , \quad t = 1,2,.... \tag{5}$$

Using the original data, the intercept and the time trend are both found to be statistically insignificant, and the estimated value of d is about 1.06 with the unit root null hypothesis not being rejected. Taking logs, the estimate of d reduces to 0.59 and the unit root

[3] Note that if $u_t$ in (1) is AutoRegressive Moving Average, ARMA(p, q), then $x_t$ is said to be AutoRegressive Fractionally Integrated Moving Average ARFIMA(p, d, q).
[4] We conduct tests of no additional serial correlation, Durbin (1970), Godfrey (1978a, 1978b) and homoscedasticity, Koenker (1981).
[5] Note that for the original data the time trend might not be the most adequate specification since a quadratic trend could be more appropriate according to Fig. 1.

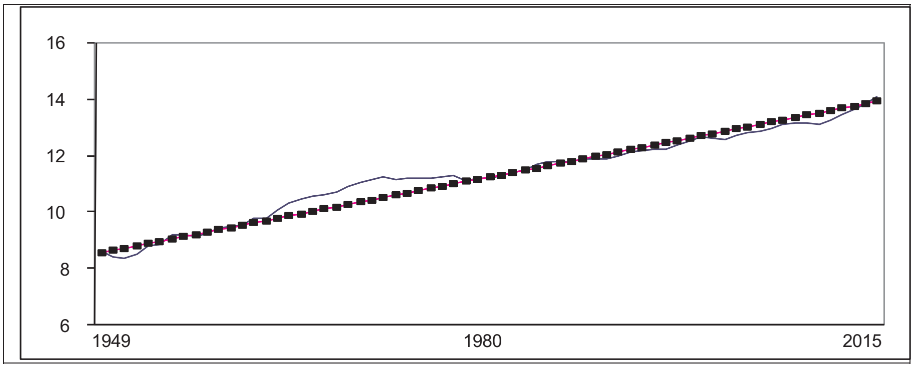


**Fig. 4.** Estimated trend for the annual data. The estimated trend is based on the following model: $y_t = 8.4502 + 0.0812\,t + x_t$; $(1–L)^{0.77}x_t = u_t$.

**Table 3**
Monthly average data.

| Month | Original data | Month | Logged data |
|---|---|---|---|
| January | 28706.50 | January | 10.09181 |
| February | 32097.57 | February | 10.15693 |
| March | 39163.14 | March | 10.37739 |
| April | 38430.64 | April | 10.43653 |
| May | 46851.14 | May | 10.61925 |
| June | 74503.78 | June | 10.09204 |
| July | 105095.29 | July | 11.47076 |
| August | 109899.57 | August | 11.51684 |
| September | 62614.57 | September | 10.89314 |
| October | 49966.21 | October | 10.64871 |
| November | 38487.14 | November | 10.31702 |
| December | 34216.86 | December | 10.17692 |

**Table 4**
Estimation based on monthly data using an I(d) model with seasonal AR errors.

| | No regressors | An intercept | A linear time trend | |
|---|---|---|---|---|
| Original data | 1.06 (0.86, 1.37) | 1.14 (0.93, 1.42) | 1.15 (0.91, 1.43) | |
| Logged transformation | 0.99 (0.88, 1.13) | 0.62 (0.56, 0.75) | 0.59 (0.46, 0.77) | |
| Month-deseasonalized | 1.17 (1.00, 1.39) | 1.14 (0.96, 1.38) | 1.14 (0.95, 1.38) | |
| First seasonal diff. log. | 0.56 (0.46, 0.69) | 0.54 (0.45, 0.67) | 0.53 (0.43, 0.66) | |
| | d | AR | Intercept coeff. | Trend coefficient |
| Original data | 1.06 (0.86, 1.37) | 0.972 | – | – |
| Logged transformation | 0.59 (0.46, 0.77) | 0.970 | 9.64028 (33.32) | 0.01215 (2.79) |
| Month-deseasonalized | 1.14 (0.95, 1.38) | 0.816 | −15364.56 (−1.95) | – |
| First seasonal diff. log. | **0.53 (0.43, 0.66)** | **−0.155** | **0.05169 (2.80)** | **0.00188 (2.11)** |

In bold the selected model according to various diagnostic tests. In parenthesis the 95% confidence band for the values of d and the t-values for the corresponding intercept and time trend coefficients.

null is now decisively rejected in favour of mean reversion (or transitory of the shocks). For the monthly deseasonalized data, d is found to be 1.14 and once more the unit root or I(1) behaviour cannot be rejected. In all these three cases the seasonal AR coefficient is relatively high, ranging between 0.816 (monthly deseasonalized data) and 0.972 (original data).[6] Taking seasonal differences into account, the estimated value of d is 0.53 (0.43, 0.66); mean reversion cannot be rejected and both the intercept and the time trend seem to be required. Several diagnostic tests carried out on the residuals support this latter specification.

Finally, the possibility of endogenous structural breaks is taken into account. A structural break takes place when there is a substantial change in the behaviour of the data. This is very important to add to the analysis as various authors have noticed that fractional integration may be a spurious phenomenon caused by the presence of undetected breaks (Granger & Hyung, 2004;

[6] Performing standard seasonal unit roots methods (Dickey, Hasza, & Fuller, 1984; Hylleberg et al., 1990) the results support the seasonal unit root model, and thus the need of seasonal differentiation, in all cases.

**Table 5**
Estimates allowing for structural breaks (Gil-Alana, 2008).

| First subsample (2003m1–2009m6) | | | Second subsample (2009m7–2016m12) | | |
|---|---|---|---|---|---|
| d | Intercept | Trend | d | Intercept | Trend |
| 0.43 (0.30, 0.62) | 0.06486 (1.98) | – | 0.34 (0.02, 0.70) | 0.05849 (1.90) | 0.00421 (4.28) |

In parenthesis the 95% confidence band for the values of d and the t-values for the corresponding intercept and time trend coefficients.

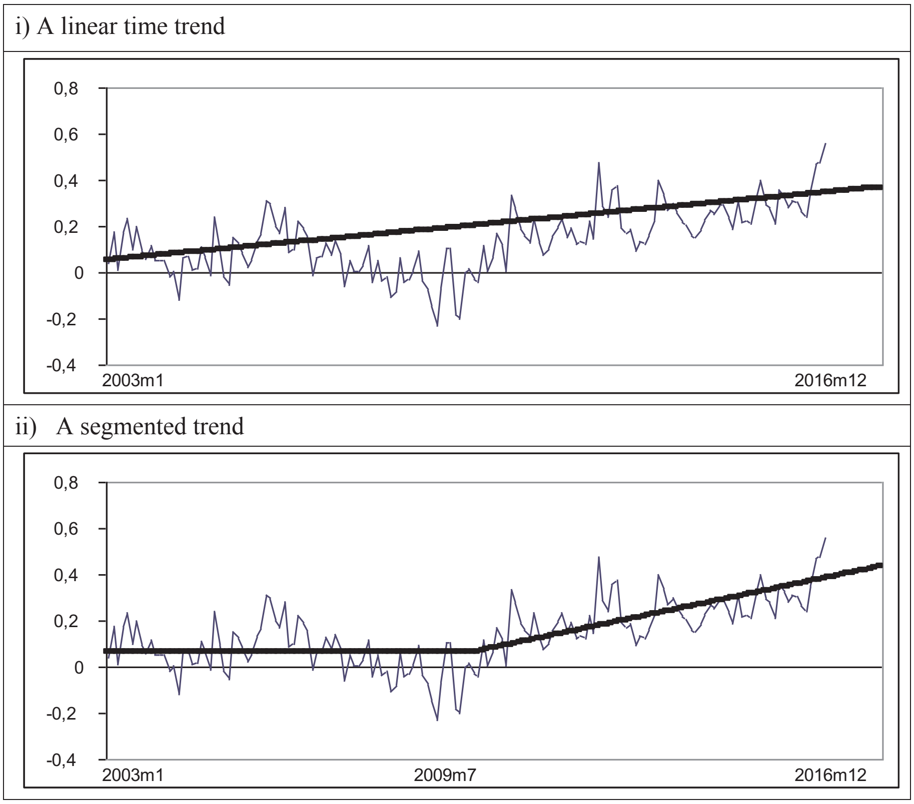


**Fig. 5.** Data and estimated trends on the monthly arrivals.

Leccadito, Rachedi, & Urga, 2014; Kellard, Jiang, & Wohar, 2015; etc.). In what follows, the approach proposed in Gil-Alana (2008) is employed that allows for fractional integration in the context of structural breaks, with the number of breaks and the break dates being endogenously determined by the model itself.

Using Gil-Alana's (2008) method, the results are displayed in Table 5. A single break is detected at June 2009, which cannot be pegged to any particular event in Icelandic tourism development. The orders of integration are 0.43 and 0.34 respectively for the first and second subsamples and the time trend is statistically significant only for the second subsample (see Fig. 5). According to these results, the series is mean reverting in both subsamples, more persistent though in the first one, and the deterministic trend during the second subsample picks up the notorious increase observed in the number of tourists in Iceland in the last 10 years.

## Concluding comments

In this paper the statistical properties of the time series illustrating inbound tourism statistics to Iceland have been examined in detail using two different frequencies (annual and monthly) and employing fractional integration or I(d) techniques. This approach is relevant for several reasons. Firstly, it allows the researcher to determine the degree of persistence of the data in a more flexible way than the standard methods employed in the literature, based on the dichotomy between the stationary I(0) and the nonstationary I(1) cases. Moreover, it permits the researcher to incorporate other observed features of the data such as seasonality and/or structural breaks, and more importantly, it can provide relevant information related to the nature of observed shocks in the series.

The results can be summarized as follows: when looking at the annual data (from 1949 to 2015) the results based on the logged data indicate the existence of a linear trend and evidence of I(1) behaviour, implying a large degree of persistence, with shocks having permanent effects. Note that the approach employed in this paper does not allow us to determine the nature of the shocks, simply arguing that these are exogenous. Reviewing the history of Icelandic tourism development nothing can be identified as an exogenous shock of the degree that could curtail tourism development until the 2000s. Then the effect of 9/11 was felt in inbound tourism statistics, as was the effect of the global economic downturn in 2008. Focusing more squarely on the monthly data (from 2003m1 to 2016m12) to better explore the post 2000 shocks the most notorious feature is the presence of a structural break at 2009m7, a time trend is found to be suitable only for the second subsample, and the orders of integration are in both subsamples positive but smaller than 1, providing evidence in favour of mean reversion behaviour. According to these results the identified shocks are expected to be transitory though somewhat persistent and taking some time to disappear.

The implication for tourism development policy in Iceland, is that strong measures need not to be taken if exogenous shocks impact on inbound tourism. Natural disasters, economic downturns and security concerns, to name but the last three identifiable exogenous shocks impacting inbound tourism to Iceland seem not to have a permanent effect. Once the impact of the shock itself, like e.g. disruption of air traffic for a month or so as Eyjafjallajökull erupted, inbound tourism growth trends are very likely to resume, at least in the Icelandic case. The current fears amongst domestic tourism entrepreneurs and the travel industry association (SAF) about the strengthening of the króna and price increases due to taxes being levied on the industry, are types of macroeconomic exogenous shocks that will impact inbound tourism. As our analysis demonstrates, then there is no cause for immediate alarm. Indeed consumptive patterns of visitors might change, but the time series analysis shows that even though tax levies and price increases with a stronger króna might have an effect on inbound tourism for the short term, the observed long term trend in the time series is likely to recover rapidly. The more general implication of this is that if strong and persistent growth trends exist in inbound tourism, these are likely to continue, despite shocks to the series. Even though these shocks might be catastrophic, e.g. in the case of natural disasters such as the Eyjafjallajökull eruption or civil unrest and warfare as in Turkey and Tunisia, tourism trends are likely to resume once the effects of the shocks have subsided. This means that the panicked marketing campaign, set up to counter the perceived negative effects of the Eyjafjalljökull eruption was unfounded and the public sector funds put into this campaign could have been better spent on preparing tourism destination infrastructure for the resumption of the inbound tourism growth trend after the volcanic eruption subsided. In light of current concerns about taxes and the strength of the Icelandic króna, policy makers should be wary of retracting tax proposals or taking actions to devalue the króna for tourism's sake. Inbound tourism is set to increase according to our analysis. More effort on behalf of policy makers should therefore be taken to remedy the regionally differentiated development of Iceland as a destination and into developing infrastructure to cope with current and projected rates of visitation.

There are still several aspects that have not been taken into account in the present paper. For instance, the possibility of other more complex nonlinear trends in the data have not been examined. Albeit still within the context of fractional integration; here, for example, the approach proposed by Cuestas and Gil-Alana (2016) could be employed allowing for non-linear trends based on Chebyshev polynomials in time. In doing so abrupt structural change observed in the data can be replaced by other rather smoother changes. Also, the possibility of examining the number of tourists in Iceland, disaggregating the data by nationality and examining the degree of persistence for each case, is another line of research that will be examined in a future paper, providing information about the degree of persistence (and thus the level of fidelity of the tourists) according to the nationality of origin.

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