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COVID-19 pre-pandemic tourism forecasts and post-pandemic signs of recovery assessment for Portugal

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ABSTRACT

Over the last decades the tourism sector has played an increasingly important role in the socio-economic development of Portugal. We analyze data from the last fifty years from Portugal, comparing non-pandemic forecasts derived with ARIMA time series models for the triennium 2020–2022, that is, forecasts obtained under the assumption that the COVID-19 pandemic would not have happened, to actual pandemic values as means to assess the impact of the pandemic on the annual numbers of guests and overnight stays in that period. The results show that full recovery has been reached in Portugal for the number of overnight stays in 2022, and individually in each main region of the country (mainland Portugal, Madeira and the Azores). However, the same cannot be said of the recovery of the number of guests, except for Madeira in 2022, whose recorded value exceeded the corresponding non-pandemic forecast value.

1. Introduction

The importance of tourism in global and national economies has been well-documented throughout the years, either by international or national institutions. The tourism sector, along with other economic sectors reliant on it, is reported to be responsible for generating wealth and creating millions of jobs worldwide. The World Travel & Tourism Council (WTTC, 2022) reports that, between 2014 and 2019, the travel and tourism sectors were responsible for 1 in 4 of all new jobs created across the world. In pre-pandemic 2019, the two sectors together accounted for 10.6% of all jobs (333 million) and 10.3% of global economy Gross Domestic Product (GDP). Moreover, according to the United Nations World Tourism Organization (UNWTO, 2020), the total international tourism receipts was USD 1,481 billion¹ in 2019, a 3% increase compared with 2018. Furthermore, UNWTO reports that, between 2009 and 2019, the real growth in international tourism receipts exceeded the growth in global GDP (54% and 44%, respectively), with Tourism being the world's third largest export category in 2019. However, all this changed drastically in 2020 after the new coronavirus SARS-CoV-2 (COVID-19) outbreak was declared a pandemic by the

World Health Organization in March of that year.

The lack of vaccines and antiviral drugs for COVID-19 in the early stages of the pandemic forced many governments to impose lockdowns, sanitary rules and severe mobility restrictions, within and across borders, to control and lower the infection rate in their countries. As a result, many economic sectors have been adversely impacted by the implementation of such measures, one being the hospitality sector which relies heavily on tourism. Following the restrictions implemented on cross-border mobility by several countries, UNWTO (UNWTO, 2022) estimates that in 2020, first year of the pandemic, the number of international tourist arrivals was 409 million, representing a 72.1% drop compared with 2019 (1,466 million). On the other hand, WTTC (WTTC, 2022) estimates that 62 million jobs were lost in the travel and tourism sectors worldwide in 2020, a 18.6% decline compared with 2019, with their share of global economy GDP falling to 5.3% (losses of USD 4.9 billion).

However, in 2021, second year of the pandemic, a small recovery of the tourism sector was seen, but with figures still far from pre-pandemic levels. UNWTO (UNWTO, 2022) reports that there were 448 million international tourist arrivals in 2021, representing a 9.5% upturn in

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¹ 1 billion = 10¹².

global tourism compared with 2020, yet a 69.4% decline compared with 2019. Moreover, WTTC (WTTC, 2022) reports that 18.2 million jobs were recovered in the travel and tourism sectors in 2021, despite the ongoing travel restrictions in that year worldwide. Nonetheless, both sectors' share of global economy GDP rose to 6.1% in 2021 (nearly USD 1 billion more than in 2020).

Through the end of 2022, the pandemic was still active due to more transmissible variants of the virus, yet less virulent than the previous ones. Nevertheless, high vaccination rates against COVID-19, especially in more developed countries, combined with mobility protocols, led to the easing of some travel restrictions in several countries, that made people feel safer to travel across borders, particularly after the middle of the year. According to UNWTO's provisional estimate (UNWTO, 2023), more than 900 million tourists traveled internationally in 2022, thus more than doubling the number recorded in 2021, but still below pre-pandemic levels.

When it comes to Portugal, tourism has become over the last years an important source of revenue for the country, and as far as to tourists' preferences goes, mainland Portugal may be seen as representative of what is happening in other Mediterranean countries of medium high-ranking tourism, while Madeira, as representative of well-established tourist destinations in high demand, and the Azores, more recently considered Europe's leading adventure tourism destination, as representative of regions with rapid tourism growth. For these reasons, and since we have access to reliable data, we shall focus on the tourism evolution in Portugal in the last fifty years, with special attention being given to the pandemic period 2020–2022.

Our main aim is to assess the impact of the COVID-19 pandemic on the annual number of guests and annual number of overnight stays, two important tourist activity indicators for Portugal's tourism sector, as well as for its economy, during the pandemic triennium 2020–2022. The methodological novelty here, improving the usual trend of comparing yearly changes, is to use pre-pandemic time series forecasts to assess the severity of the pandemic impact on tourism activity and the level of recovery after the pandemic control. The time series analyzes are performed using all data available until 2019 to obtain mean forecasts for each year of the triennium, using ARIMA models, under the assumption that the pandemic would not have happened. Forecasts are also obtained for each of the country's three main regions, namely mainland Portugal, Madeira and the Azores, according to level I territorial units for statistics (NUTS I), as used by "Instituto Nacional de Estatística" (INE – Statistics Portugal). This approach will allow us to address the following questions:

1. If the pandemic would not have happened, what growths would Portugal, and its main regions individually, be expecting for the annual number of guests and annual number of overnight stays in the triennium 2020–2022?
2. What are the expected falls for the two indicators in the pandemic period 2020–2022?
3. When can full recovery of the two indicators be expected based on forecasts and true values (i.e., recorded values)?

This paper is organized as follows. In Section 2, we give a brief background on the development of tourism in Portugal. In Section 3, we review some literature on the impact of COVID-19 on tourism and the economy, first on a global level in Subsection 3.1, and on the Portuguese case in Subsection 3.2. In Section 4, some basic concepts for time series analysis are discussed, as well as some information on ARIMA models used in the analysis. In Section 5, we indicate the data source and methodology used to forecast the annual mean number of guests and annual mean number of overnight stays for each year of the triennium 2020–2022, under a non-pandemic scenario. The main Section 6 gives a detailed statistical analysis of the data, with Subsection 6.1 showing some tourism statistics for Portugal over the period 1969–2022, and Subsection 6.2 displaying the ARIMA forecasts, thus allowing a deeper

insight on the vulnerability of tourism activity exerted by the COVID-19 pandemic. The main results of Section 6 are discussed in Section 7 and the main conclusions are presented in Section 8.

2. Some background on the development of tourism in Portugal

Portugal is a small European country (total area of 92,212 km²) with just over 10 million inhabitants (2021 census) and is located at the extreme southwest of Europe. It is composed of three main regions, the mainland area, in the European continent, and the Atlantic archipelagos of Madeira and of the Azores.² It has an extensive coastline of approximately 987 km long in the continental sector (Santos et al., 2017), 193 km in Madeira Island and Porto Santo Island, the only inhabited islands of the archipelago of Madeira (APRAM, 2023), and 1,170 km in the archipelago of the Azores (Barroco et al., 2012).

The development of tourism in Portugal started to be considered important at the end of the 19th century and beginning of the 20th century, mainly to try to solve the economic crisis that the country was facing at that time. However, only in the 1960s, with the expansion of commercial air travel, the development of tourism really started to take off in Portugal. At that time, Algarve, located at the southern region of the mainland territory, becomes more recognized outside by its good weather³ and more attractive as a tourist destination in the country (especially to English and German tourists). Aside from being a destination of choice for many foreigners, the southern region of Portugal has also been over the years a very popular holiday destination of many middle and upper class Portuguese, especially during the summer. With tourism gaining by the 1960s some relevance and consequently becoming an important source of revenue for Portugal, INE starts publishing in 1970 its annual reports on national tourism statistics ("Estatísticas do Turismo" series). In pre-pandemic 2019, the revenue from tourism represented 15.3% of Portugal's GDP (INE, 2021a) and 9.6% of the total employment in the country were linked to activities in the tourism sector.

As for the development of tourism in the archipelago of Madeira, historians claim that it began much earlier, in the 15th century, because of Madeira's strategic position in the Atlantic Ocean, which allowed it to support commercial traffic for the exploration of new continents (America, Asia and Africa). However, tourist activity in Madeira only becomes truly consistent at the end of the 18th century and beginning of the 19th century, when it began to be publicized as a good place to recover from lung diseases in international medical guides due to its climate characteristics, which also functioned to promote tourism in the archipelago (Silva, 1985). Since then, the archipelago has developed many infrastructures to support the development of tourism in the region, namely a considerable number of hotels and other types of tourist accommodations establishments, and marina and seaport conditions for pleasure boats and cruise ships. Although Madeira has also been a popular destination of choice for many Portuguese citizens, the majority of the archipelago's tourists has been over the years foreigners. Nowadays, tourism plays a major role in Madeira's economy and in its social development. In 2019, the Gross Value Added (GVA) directly generated

² The archipelago of Madeira has two inhabited islands (Madeira and Porto Santo), two groups of uninhabited islands (Desertas and Selvagens, with three islands each), and six islets. The archipelago of the Azores has nine islands (all inhabited) spread across three groups according to their geographical location: the eastern group (Santa Maria and São Miguel), the central group (Terceira, Faial, Pico, Graciosa and São Jorge) and the western group (Flores and Corvo).

³ According to Köppen's classification, Portugal has a temperate climate, with different subtypes throughout its territory. The northern region of the mainland area is mostly classified as Csb (dry and mild summers) and the southern region mainly as Csa (dry and hot summers). Madeira's climate is of subtype Csa, while the Azores' climate of subtype Csb in the eastern group of the archipelago and of subtype Cfb (also known as an oceanic climate) in both the central and western groups (IPMA, 2023).

by tourism in Madeira represented 16.2% of the region's GVA revenue that year, with 17.0% of the work force of the archipelago being employed in the tourism sector (DREM, 2023).

Regarding the development of tourism in the Azores, only more recently this archipelago has been on international tourism radars. According to Silva (2020), this archipelago has had some visitors throughout the 19th century but didn't experience the same growth in tourism that was being seen in Madeira Island, which was highly praised by its climate characteristics. On the other hand, the scarcity of essential infrastructures for visitors in the Azores, namely guesthouses and hotels, highlighted by those who visited the region, was an obstacle to the further development of tourism in the archipelago. Therefore, until the Portuguese revolution in 1974, and even some time after, the Azores was a more secluded region, whose main source of revenue came from the agricultural sector and livestock farming (mainly cattle). Moreover, until quite recently, the accessibility to the region by air was rather limited. Furthermore, before the coming of the first low-cost airline to the Azores in 2015 (mainland Portugal received its first low-cost flights in 1995 and Madeira in 2008 (INAC, 2012)), following the liberalization of air traffic by the Autonomous Government of the region in 2015, one of the main reasons given by interested tourists for not choosing the Azores as a destination was the high price of air tickets for just a two-hour flight from the mainland territory. However, at the turn of the 21st century the number of visitors, which had been until then mostly from the mainland territory or emigrants originally from the Azores who came to visit relatives, started to grow more visibly. One of the reasons for this increase was the fact that from 2005 onwards, the Regional Tourism Association began to promote the archipelago not just as a destination of landscape diversity and beauty, but also as a place to experience adventures (Silva and Almeida, 2011). More information on the recent development of tourism in the Azores can be found in Silva (2013) and other references therein. In 2019, the GVA directly generated by tourism in the Azores represented already 10.6% of the region's GVA revenue that year (SREA, 2023).

More details on the development of tourism in Portugal can also be found, for example, in Pina (1988), Milheiro and Santos (2005), Cunha (2010), and Moreira (2018).

3. Literature review

3.1. Global economy and COVID-19

To deal with the COVID-19 pandemic, unprecedented extreme measures were enforced by many governments (e.g., curfews, lockdowns, social distancing and mobility restrictions), causing negative impacts in some way, shape or form. The one-size-fits all policies adopted by most governments revealed to be quite detrimental to many economic activities, because of the closure of all non-essential businesses. Despite the economic aids packages and fiscal measures implemented by many governments to avoid workers being laid off and the bankruptcy of businesses, no one managed to stay immune to the negative effects of the pandemic, in which services and small businesses were the most affected. Among the services sector, the hospitality sector was greatly impacted since "unlike other business sectors, tourism revenue is permanently lost because of unsold capacity", which cannot be marketed in the following years (Gösling et al., 2021).

One of the very first assessments of the economic impact of COVID-19 across industries and countries is the report by Fernandes (2020), where rough estimates of the potential global economic costs of the pandemic are given under different shutdown scenarios of 1.5, 3 and 4.5 months. For a mild shutdown scenario of 1.5 months, it was estimated that the COVID-19 economic impact, expressed as percentage of GDP, would be between 3.5% and 6%. Countries whose GDP is heavily dependent on tourism, would be the most affected, such as Greece (−6.2%), Portugal (−5.9%), Mexico (−5.4%) and Spain (−5.2%). For more severe shutdown scenarios of 3 and 4.5 months, Portugal shows up

Table 1

Portugal's main European tourist market share of the total in 2019–2022 (%).

Country	2019	2020	2021	2022
Spain	25.0	28.5	30.2	25.8
France	12.6	16.3	16.1	13.1
United Kingdom	15.4	12.7	10.6	13.2
Germany	7.9	8.5	8.0	12.6

in the first place among the countries with a greater drop in their GDP, with estimates of −8.8% and −14.0%, respectively. In Gösling et al. (2021) comparisons are also made between the economic impacts of the COVID-19 pandemic and previous epidemics and pandemics, and other types of global crises. It is highlighted in the paper that "there is much evidence that COVID-19 will be different and transformative for the tourism sector".

Other papers and reports are available on global and local economic impacts of COVID-19. For example, a good overview of the global economic effects of the pandemic through the end of 2021 is the Congressional Research Service report (CRS, 2021), where global economic costs of the pandemic are given, as well as the response by governments and international institutions to address the effects of the pandemic. Despite the poor results seen in the first year of the pandemic for most economies, "the economic downturn in 2020 was not as negative as initially estimated, partially due to the fiscal and monetary policies governments adopted in 2020". The report shows that almost all major countries had a drop in their GDP growth rate for 2020, compared with 2019, except for China in the second quarter of 2020 compared with the first quarter of that year.

On the other hand, according to the World Economic Outlook (WEO) of October 2021 by the International Monetary Fund (IMF, 2021), global economic growth fell to an annualized rate of −3.1% in 2020, but with an upturn of 5.9% for 2021 and 4.9% for 2022 being estimated. For 2021, IMF forecasted an uneven pace of recovery of the global economy for different regions because of different rates of vaccination, the extent of national support policies and other structural conditions, such as the role of tourism in the economy. Nevertheless, in the last quarter of 2021, with the emergence of the more virulent Delta variant of the virus, national economies suffered again some setbacks. Nonetheless, IMF did not revise the forecasts for 2022 in their WEO of October 2022 (IMF, 2022).

Papers and reports just focusing on the impacts of the pandemic on the hospitality industry, food services and labor market in some countries have also become available. Some examples are Canjer et al. (2020), Huang et al. (2020), Napierala et al. (2020), Kim et al. (2020), Telukdarie et al. (2020), Kosmala (2021), and Anguera-Torrell et al. (2021). Moreover, rebound and revival strategies from the pandemic have as well been the focal point of other papers, such as Sigala (2020), Sanabria-Díaz et al. (2021), Sharma et al. (2021), and McTeigue et al. (2021).

3.2. Portugal, tourism and COVID-19

In pre-pandemic 2019, the number of non-residents tourists arriving at Portugal reached 24.6 million, a 7.9% growth compared with 2018. However, in 2020, first year of the pandemic, this number is estimated to have only reached 6.5 million, representing a 73.7% drop compared with 2019. But the downward trend seen in the number of non-residents tourists in 2020 was reversed in the following two years, it rose to 9.6 million in 2021 and to 22.3 million in 2022. Despite the 131.4% growth observed in 2022 compared with 2021, the 2022 value was still 9.6% below the 2019 value (INE, 2020, 2021b, 2022, 2023).

Over the last years, the main Portuguese tourist market has been European, mostly from Spain. Outside Europe, Brazil, United States and Canada have also been important markets, much due to Brazil having a historical connection to Portugal and in North America lying a big Portuguese emigrant community.

In Table 1, we show the share of the total of Portugal's top 4 European tourist market between 2019 and 2022 (INE, 2020, 2021b, 2022, 2023).

According to INE's tourism satellite account (INE, 2021a), the tourism sector's share of national GDP was 15.3% in 2019 (14.8% in 2018). However, in 2020, the share of GDP fell to 8.4%, but then rose to 10.1% in 2021 (provisional estimate). Although the 2021 figure is below pre-pandemic values seen between 2016 and 2019, it does show some signs of recovery of the sector in the country compared with 2020, as generally observed worldwide for that year. Moreover, the GVA directly generated by tourism in 2020 was only 8,382 million euros, thus indicating a contraction of 44.5% compared with 2019, and representing a 4.8% of GVA national revenue, whereas in 2019 it was 8.1%. Nonetheless, in 2021, the GVA generated by tourism in the country increased to 10,671 million euros, a 5.8% of GVA national revenue, but still below the minimum value observed between 2016 and 2019 (6.9% in 2016). The official figures for 2022 have not yet been released by INE at the time of the writing of this paper and therefore cannot be shown here.

Some authors have also assessed the impacts of the pandemic on Portugal's tourism sector, labor market and food services. For example, Espírito Santo et al. (2021) forecast that, once total recovery of Portugal's tourism sector occurs from the pandemic, the country may have accumulated losses of 60 thousand million euros in GDP and eliminated almost 600 thousand direct or indirect jobs related to the sector. It is forecasted as well that full recovery of pre-pandemic levels will not be observed before 2023. In Costa (2021), the evolution and impact of COVID-19 on the tourism and travel sectors are assessed through a regional comparative analysis using some indicators (e.g., number of guests and number of overnight stays). It is shown that the Autonomous Regions of Madeira and of the Azores are the two regions of the country that experienced the most significant decrease in the performance of important tourism indicators in the first year of the pandemic.

Concerning the impact of the pandemic on the labor market, Almeida and Santos (2020) and Lopes et al. (2021) have similar findings in the sense that more populated and tourist regions were more affected, with the most vulnerable workers to COVID-19 unemployment being the older, less educated and qualified, women and young people. In addition, the findings in Santos and Moreira (2021) are that, after the first phase of the pandemic, there was a slight recovery of some tourism activity indicators, mainly in more consolidated tourist destinations, such as Algarve and Madeira. Moreover, low-density territories in the mainland area suffered a less severe impact on tourism demand, with domestic tourism contributing to lessen some of its adverse effects.

As to the impact of the pandemic on the food services, the main findings in Madeira et al. (2020) are the existence of common concerns to all entrepreneurs in the restaurant business for the post-pandemic period, more precisely about measures and strategies to be adopted by the Portuguese Government to cope with future similar crises. On the other hand, the findings in Brilhante and Rocha (2023), which only apply to São Miguel, the biggest island of the Azores, are that the local accommodation sector was the most affected in 2020, with an estimated income drop of 78.7% compared with 2019, followed by income drops of 74.7% for the hotel sector and 58.5% for the restaurant sector. Moreover, for both types of tourist accommodations considered in those authors' analysis, the mean occupancy rate during the summer of 2020 is estimated to have fallen 60% compared with 2019.

4. Basic concepts and models for time series analysis

Since the main results in Subsection 6.2 are based on the analysis of time series, we shall briefly explore some basic concepts and models used in the analysis to improve the comprehensibility of the subject of a more unfamiliar reader.

A time series is a stochastic process, more precisely, a sequence of random variables $\{X(t) : t \in T\}$ which yields data points in a chronological order, and therefore argument t is considered a time parameter. If

T is a discrete set of values, the time series is said to be discrete and it can be simply represented by $\{X_t\}$. From a mathematical standpoint, discrete time series are generally easier to handle than the continuous versions, and since most time series are recorded at time intervals, discrete time series are quite common. These are the type of time series we shall be dealing with here.

One main goal of time series analysis is to forecast values outside the observed time range, that is, to predict (unknown) future observations with a certain precision. Classical statistical methods, such as regression analysis, are inappropriate to deal with these data since there is correlation between the sampling of observations of adjacent points in time, which does not happen in the classical framework, where the sampling of observations is from independent and identically distributed random variables.

But forecasting with time series requires models, which in turn will demand some form of regularity of the behavior of the series over time. Most often what is necessary is a time series $\{X_t\}$, with finite variance $\text{var}(X_t) = \sigma^2$, to be weakly stationary. This will occur if the mean function $\mu_t = E(X_t)$ is constant and does not depend on time t , and the autocovariance function $\gamma(s, t) = \text{cov}(X_s, X_t) = E[(X_s - \mu_s)(X_t - \mu_t)]$ depends on times s and t only through $|s - t|$. Normally, the autocovariance function is rewritten as $\gamma(h) = \gamma(t, t+h)$, $h = 0, 1, 2, \dots$ (note that $\gamma(h) = \gamma(-h)$).

Although useless for forecasting purposes, an important weakly stationary process that shows up in models is white noise, which is a sequence of non-correlated random variables with mean zero and variance σ^2 . Moreover, the inspection of the autocorrelation function, $\rho(h) = \text{corr}(X_t, X_{t+h})$, and partial autocorrelation function, which measures the correlation between X_t and X_{t+h} after removing the linear effect between times t and $t+h$, are used to clarify relations that may occur within time series at various lags h , and therefore can suggest a particular model to fit the data.

Two fundamental models for discrete time series are the autoregressive and the moving average models. An autoregressive model of order p , denoted by $\text{AR}(p)$, is a regression model with lagged variables of the form

$$X_t = \phi_1 X_{t-1} + \phi_2 X_{t-2} + \dots + \phi_p X_{t-p} + W_t, \quad (1)$$

where $\{X_t\}$ is (weakly) stationary, $\phi_1, \phi_2, \dots, \phi_p$ are constants, with $\phi_p \neq 0$, and $\{W_t\}$ is white noise. A drift model can also be considered, which results by adding a constant δ ($\delta \neq 0$) to the right-side of (1). On the other hand, a moving average model of order q , denoted by $\text{MA}(q)$, is of the form

$$X_t = W_t + \theta_1 W_{t-1} + \theta_2 W_{t-2} + \dots + \theta_q W_{t-q}, \quad (2)$$

where $\theta_1, \theta_2, \dots, \theta_q$ are constants, with $\theta_q \neq 0$, and $\{W_t\}$ is white noise. Using the backward shift operator B defined by $BX_t = X_{t-1}$, model (1) can be rewritten as

$$(1 - \phi_1 B - \phi_2 B^2 - \dots - \phi_p B^p)X_t = W_t \Leftrightarrow \phi(B)X_t = W_t. \quad (3)$$

Note that $B^2 X_t = B(BX_t) = X_{t-2}$, and more generally $B^k X_t = X_{t-k}$.

The properties of the autoregressive operator $\phi(B)$ are important in solving Eq. (3) for X_t . In order for a $\text{AR}(p)$ process to be stationary, the roots of the autoregressive polynomial $\phi(z) = 1 - \phi_1 z - \phi_2 z^2 - \dots - \phi_p z^p$, with z complex, must lie outside the unit circle, i.e., the solutions of $\phi(z) = 0$ must satisfy $|z| > 1$. Similarly, model (2) can be rewritten as

$$X_t = (1 + \theta_1 B + \theta_2 B^2 + \dots + \theta_q B^q)W_t \Leftrightarrow X_t = \theta(B)W_t,$$

where $\theta(B)$ is the moving average operator. Unlike AR processes, MA processes are always stationary.

A more general time series model that joins an autoregressive process of order p and a moving average process of order q is an autoregressive moving average model of order (p, q) , denoted by $\text{ARMA}(p, q)$. Note that

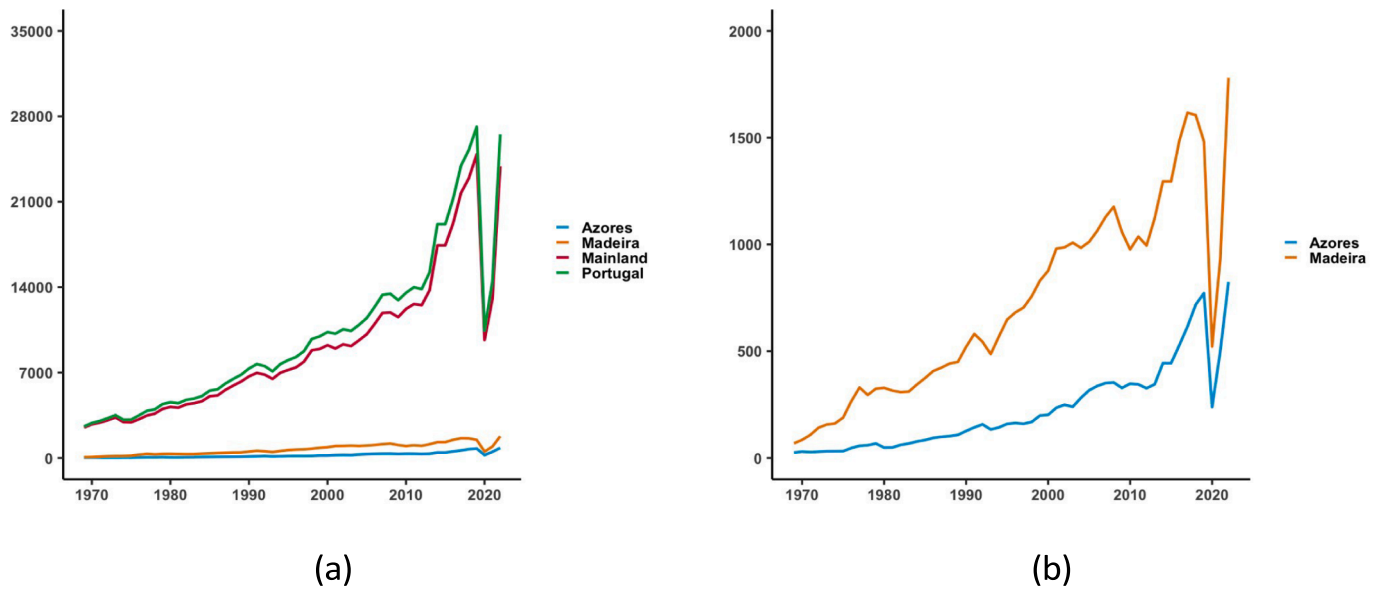


Fig. 1. Annual number of guests (in thousands) in tourist accommodation establishments between 1969 and 2022: (a) Portugal and NUTS I regions. (b) Autonomous Regions.

$\text{ARMA}(p,0) = \text{AR}(p)$ and $\text{ARMA}(0,q) = \text{MA}(q)$. We are interested in ARMA models that are causal, meaning that the time series can be written as a one-sided linear process, i.e., $X_t = \sum_{j=0}^{\infty} \psi_j W_{t-j}$, where the ψ_j 's are constants, with $\psi_0 = 1$ and $\sum_{j=0}^{\infty} |\psi_j| < \infty$. A $\text{ARMA}(p,q)$ process will be causal only if the roots of the autoregressive polynomial $\phi(z)$ lie outside the unit circle. Like AR and MA models, ARMA models can be written in a concise form as

$$\phi(B) = \theta(B)W_t.$$

When dealing with non-stationary processes, differencing can transform non-stationary time series into stationary time series. The first difference of a time series is denoted by $\nabla X_t = X_t - X_{t-1}$, which can be expressed as a function of the backward shift operator as $\nabla X_t = (1-B)X_t$. The second difference is defined as $\nabla^2 X_t = \nabla(\nabla X_t) = \nabla(1-B)X_t = (1-B)^2 X_t$, with operator $(1-B)^2$ being treated as an ordinary polynomial of order 2. More generally, the difference of order d is defined as $\nabla^d X_t = (1-B)^d X_t$. Therefore, non-stationary models can use differencing to end up working with stationary processes. This is the case with the versatile autoregressive integrated moving average models, or ARIMA models, that will be used in Subsection 6.2.

Therefore, a time series $\{X_t\}$ is a $\text{ARIMA}(p,d,q)$ process if, for a non-negative integer d , the time series $\{Y_t\}$, with $Y_t = (1-B)^d X_t$, is a causal $\text{ARMA}(p,q)$ process. This basically means that $\{X_t\}$ satisfies a difference equation of the form

$$\phi(B)(1-B)^d X_t = \theta(B)W_t, \quad (4)$$

where $\phi(B)$ and $\theta(B)$ are the autoregressive and moving average operators, respectively. An extension of ARIMA models are SARIMA models which incorporate a seasonal component as well. Since the latter do not apply to our data, we shall not explore them here, and the same goes for other possible time series models.

After a model fit, diagnostics on the residuals should be performed. If a model fits well, the standardized residuals should behave as a non-correlated sequence with mean zero and variance one. The absence of serial correlation of the residuals can be checked using, for example, the Ljung-Box test, which tests the overall randomness based on a number of lags. Moreover, if competing models who have passed the diagnostic stage exist, one model must be chosen, and for this task the Akaike's Information Criterion (AIC) can be used to measure the goodness-of-fit

of each model candidate (Akaike, 1969). The model with the smallest AIC has the (overall) best fit and therefore should be chosen, unless other reasonable criteria are considered, for example, the practicality of more parsimonious models. Furthermore, when small samples are involved a more suitable model selection criterion is the bias corrected AIC (AICc). The AICc converges to the AIC value when the sample size goes to infinity. As an alternative measure to AIC, the Bayesian Information Criterion (BIC) can be used for model selection. Simulation studies have shown that BIC performs well in large samples, whereas the AICc tends to be superior in smaller samples. For more information on model selection, see Burnham and Anderson (2002).

Once a model has been chosen, one can finally move on to forecasting, with the goal being to use the observed time series x_1, x_2, \dots, x_n to predict future values x_{n+m} , $m = 1, 2, \dots$, which can be accomplished using best linear predictors for stationary processes.

For a comprehensive outlook on time series analysis consult, for example, Brockwell and Davis (2016), or Shumway and Stoffer (2010).

5. Material and methods

All data used in Section 6 were taken from INE's Tourism Statistics series since its first publication in 1970 up to its latest in 2023 (INE, 1970–2023). The selected information concerns mainly two important tourist activity indicators, the annual number of guests and the annual number of overnight stays in tourist accommodation establishments, between 1969 and 2022, for the whole country and each NUTS I region.

The collected data on the number of guests and number of overnight stays are used to perform a time series analysis to obtain mean forecasts for each year of the pandemic period 2020–2022 and indicator, that is, under the assumption that the pandemic would not have happened. This was done after fitting the best ARIMA model (4) to the observed time series from 1969 to 2019 for each case.

The order (p, d, q) selection of the ARIMA models was obtained by minimizing the AICc, a more suitable model selection criterion for small samples for model candidates, as mentioned in Section 4. To work with more parsimonious models, the search for the best fit was limited to models with $0 \leq p, q \leq 5$ and $d = 1$ (no substantial improvement was observed by taking $d = 2$). Each model candidate underwent the usual residual diagnostics, namely checking if the standardized residuals behaved as a non-correlated sequence with mean zero and variance one. The Ljung-Box test was also used for testing the overall randomness of

Table 2

Yearly changes in the number of guests in 2019–2022 in the territory (%).

Region	2019/ 2018	2020/ 2019	2021/ 2020	2021/ 2019	2022/ 2021	2022/ 2019
Portugal	+7.5	−61.6	+38.6	−46.7	+83.4	−2.3
Mainland	+8.6	−61.1	+34.7	−47.7	+83.6	−3.9
Azores	+7.5	−69.1	+110.3	−35.1	+64.6	+6.9
Madeira	−7.7	−64.8	+78.7	−37.0	+90.8	+20.1

the residuals (up to lag 20). Moreover, if a small difference between two satisfactory models was observed, more precisely, AICc less than 2, the model with the smallest residual standard deviation estimate (σ) was chosen.

Once a model was selected, expected growths were estimated for each year of the period 2020–2022. A comparison was made as well between forecasts and true values, so that expected falls could be estimated for each year and indicator, therefore giving a more accurate impact assessment of the pandemic on the two indicators considered.

The software used to perform the statistical analysis was R: A language and environment for statistical computing (R Core Team, 2022).

6. Results

6.1. Some tourism statistics

6.1.1. Number of guests

In Fig. 1, we show the annual number of guests for the whole country between 1969 and 2022 (green line in Subfigure 1a), along with the annual number of guests in tourist accommodation establishments for each NUTS I region, i.e., mainland Portugal and the two Autonomous Regions of Madeira and of the Azores. Subfigure 1b zooms in Subfigure 1a for the Autonomous Regions alone to allow comparisons between the two archipelagos.

From Subfigure 1a we see that, until 2019, there has been an upward trend in the number of guests in Portugal, which is also reflected in each of its main regions, with a steeper increase since 2010. However, in 2020, year when the pandemic started, this upward trend was drastically reversed to numbers comparable to those recorded back in the beginning of the 2000s, i.e., 20 years back in time, except for Madeira where a bigger setback to the 1990 value was observed. In 2021, a small recovery was seen, with figures being now close to those recorded back in the first half of the 2010s, but still far from the numbers observed in pre-pandemic 2019. In 2022, second year of the pandemic, an almost total recovery of pre-pandemic levels was seen for Portugal, since the number of guests in the country represented a 97.7% of the 2019 value. Interestingly enough, pre-pandemic levels were exceeded in both archipelagos, in Madeira by 20.1% and in the Azores by 6.9%, thus

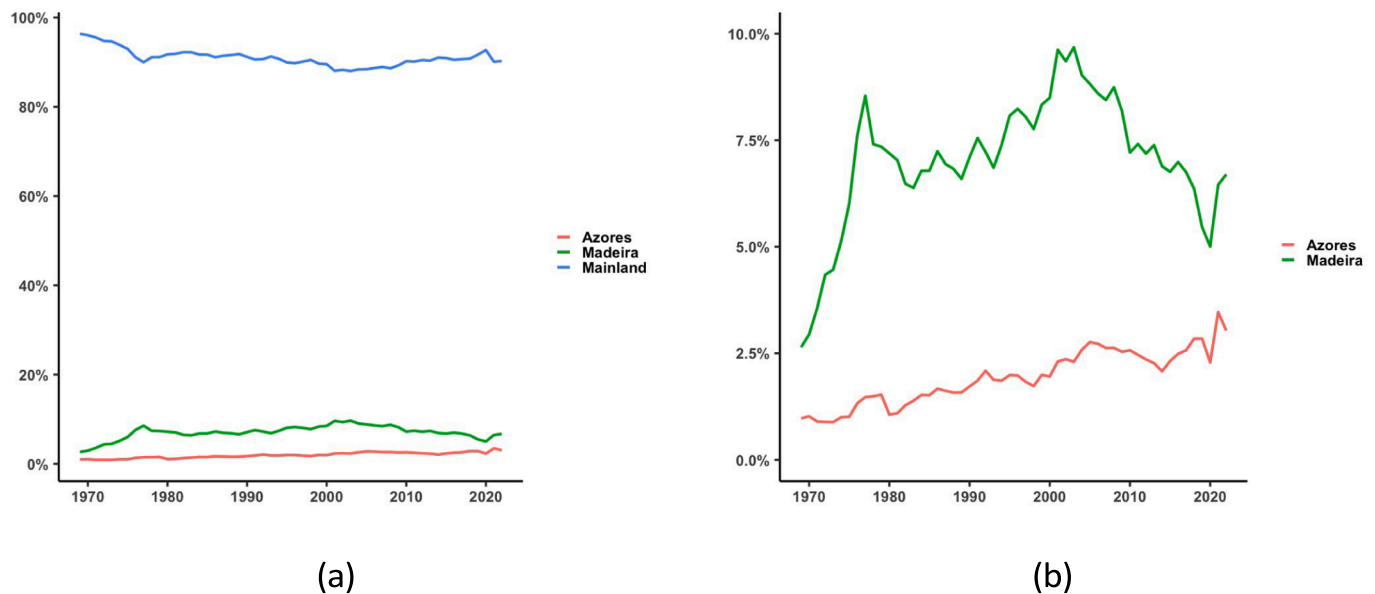


Fig. 2. NUTS I regions' share of the country's number of guests between 1969 and 2022: (a) NUTS I regions. (b) Autonomous Regions.

Table 3

Statistics for NUTS I regions' share of the country's number of guests (%).

Region	1969–2019							2020	2021	2022
	Min	Q_1	Q_2	Mean	Q_3	Max	SD			
Mainland	88.0 (2003) ¹	90.0	90.8	91.0	91.7	96.4 (1969) ¹	1.9	92.7	90.1	90.2
Azores	0.9 (1973) ¹	1.5	1.9	1.7	2.4	2.8 (2018) ¹	0.6	2.3	3.5	3.1
Madeira	2.6 (1969) ¹	6.6	7.2	7.1	8.1	9.7 (2003) ¹	1.5	5.0	6.4	6.7

¹Year in which the value was recorded.

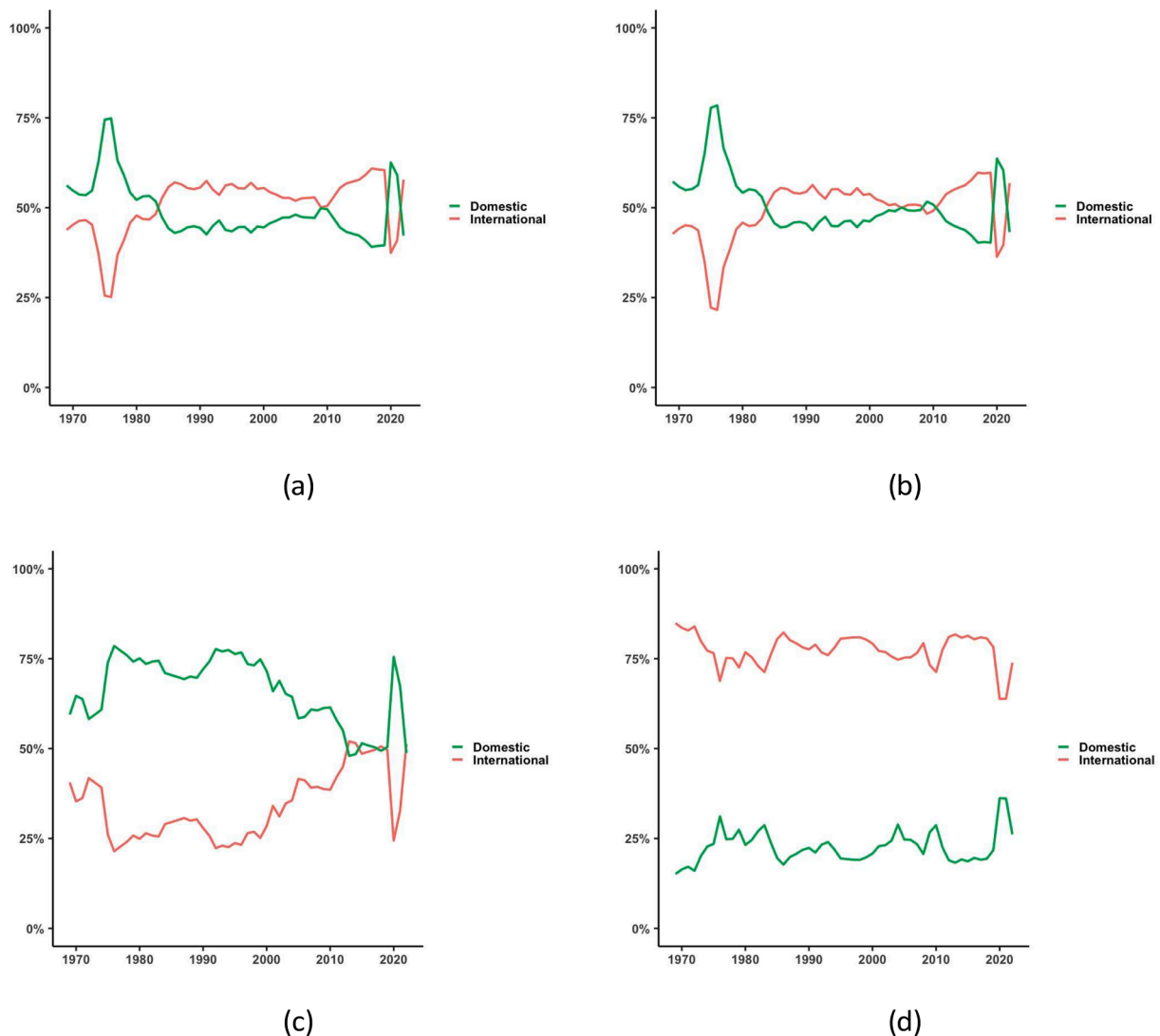


Fig. 3. Guest type share of the number of guests between 1969 and 2022: (a) Portugal. (b) Mainland. (c) Azores. (d) Madeira.

showing an actual growth in 2022 compared with 2019 in these two regions.

On the other hand, when both archipelagos are compared with each other, it is noticeable that Madeira has always had higher values than the Azores, even during the pandemic years, with a steeper upward trend in the number of guests. The difference observed between the two archipelagos is clearly explained by the fact that Madeira has been over many years one of Portugal's tourist destination regions most sought after, mainly by international tourists.

Table 2 shows the percentage of yearly observed changes in the number of guests during the period 2019–2022.

To weigh the contribution of each NUTS I region to the country's number of guests between 1969 and 2022, Fig. 2 is shown, with Subfigure 2b zooming in Subfigure 2a just for the Autonomous Regions.

We see that the mainland region has always been the major contributor to the country's number of guests, being responsible for at least 88.0% and at most 96.4% throughout the years. Moreover, Madeira's contribution has been between 2.6% and 9.7%, whereas the Azores, between 0.9% and 3.5%, with this maximum value being recorded in the pandemic year 2021. Nonetheless, when just looking at the Autonomous Regions, we observe a slow upward trend in the Azores' share over the years and an apparent downward trend in Madeira's share between 2003 and 2020, yet always above 5% for the latter.

In Table 3, more statistics for NUTS I regions' share of the country's

number of guests between 1969 and 2022 are given, with Min, Q_1 , Q_2 , Q_3 , Max and SD standing for the minimum, 1st quartile, median (2nd quartile), 3rd quartile, maximum and standard deviation, respectively.

On the other hand, Fig. 3 shows the share of the number of guests in tourist accommodation establishments due to guest type (domestic or international) between 1969 and 2022 for Portugal and NUTS I regions.

We see that ever since 1984, the share due to international guests in the country's establishments has always exceeded the share due to domestic guests, but this cycle has been broken in 2020 with the pandemic. The same pattern is also reflected in the mainland area. However, the share due to international guests in Madeira's tourist accommodation establishments has consistently been higher since 1969, even during the travel restrictive years of 2020 and 2021. As for the Azores, before the pandemic, the share due to international guests in the region's establishments only was bigger than the share due to domestic guests in the years of 2013, 2014 and 2018.

As somewhat expected, in 2020 and 2021, the number of domestic guests was bigger than the number of international guests, the only exception being Madeira's case. This shows that domestic tourism was, in general, a positive key factor in the first two years of the pandemic for the recovery of the country's hospitality sector. In 2022, all regions recorded greater shares due to international guests in tourist accommodation establishments (Portugal: 57.8%; Mainland: 56.8%; Azores: 51.3%; Madeira: 73.9%).

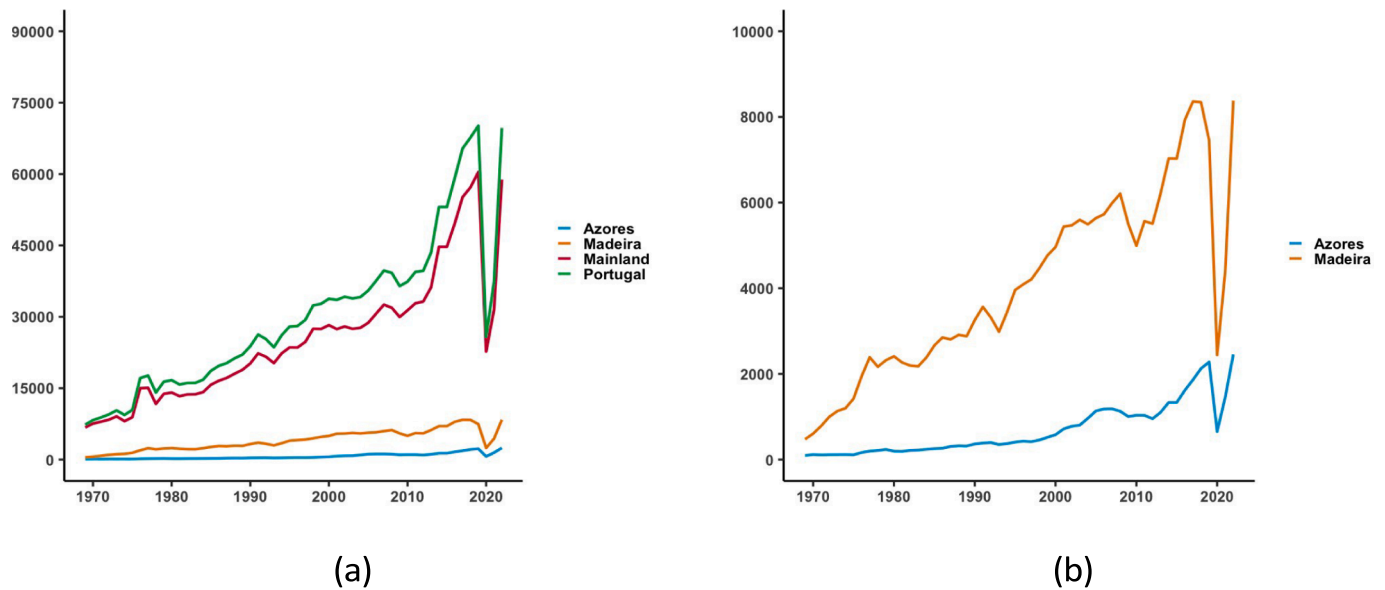


Fig. 4. Annual number of overnight stays (in thousands) in tourist accommodation establishments between 1969 and 2022: (a) Portugal and NUTS I regions. (b) Autonomous Regions.

Table 4

Yearly changes in the number of overnight stays in 2019–2022 in the territory (%).

Region	2019/ 2018	2020/ 2019	2021/ 2020	2021/ 2019	2022/ 2021	2022/ 2019
Portugal	+3.7	−63.2	+44.7	−46.8	+86.7	−0.7
Mainland	+5.7	−62.4	+38.7	−47.9	+87.0	−2.6
Azores	+7.2	−71.3	+122.6	−36.1	+68.8	+7.9
Madeira	−10.6	−67.3	+80.0	−41.1	+90.6	+12.4

6.1.2. Number of overnight stays

In Fig. 4, the annual number of overnight stays in tourist accommodation establishments between 1969 and 2022 is shown for the country and each NUTS I region. Subfigure 4b zooms in Subfigure 4a just for the two Autonomous Regions.

The patterns seen in Fig. 4 are quite like those observed in Fig. 1 for

the number of guests. The 2020 figures for the country and mainland region overnight stays are comparable to those recorded back in the beginning of the 1990s, approximately 30 years back in time. The 2020 Azores' number is comparable to the one recorded back in the beginning of the 2000s, but Madeira's figure goes even further back in time, near to the one recorded in 1984. Nevertheless, the 2021 figures do also show some recovery compared with 2020, being now close to those recorded back in 2006 for the country, in 2010 for the mainland region, and in 2014 and 2015 for Madeira and the Azores, respectively.

As found for the number of guests, in 2022, an almost total recovery of pre-pandemic levels was seen for the number overnight stays for Portugal, representing a 99.3% of the 2019 value (97.4% for the mainland region). Pre-pandemic levels were again exceeded in the two archipelagos for the number of overnight stays in 2022, in Madeira by 12.4% and in the Azores by 7.9%.

Table 4 indicates the percentage of yearly observed changes in the number of overnight stays during the period 2019–2022.

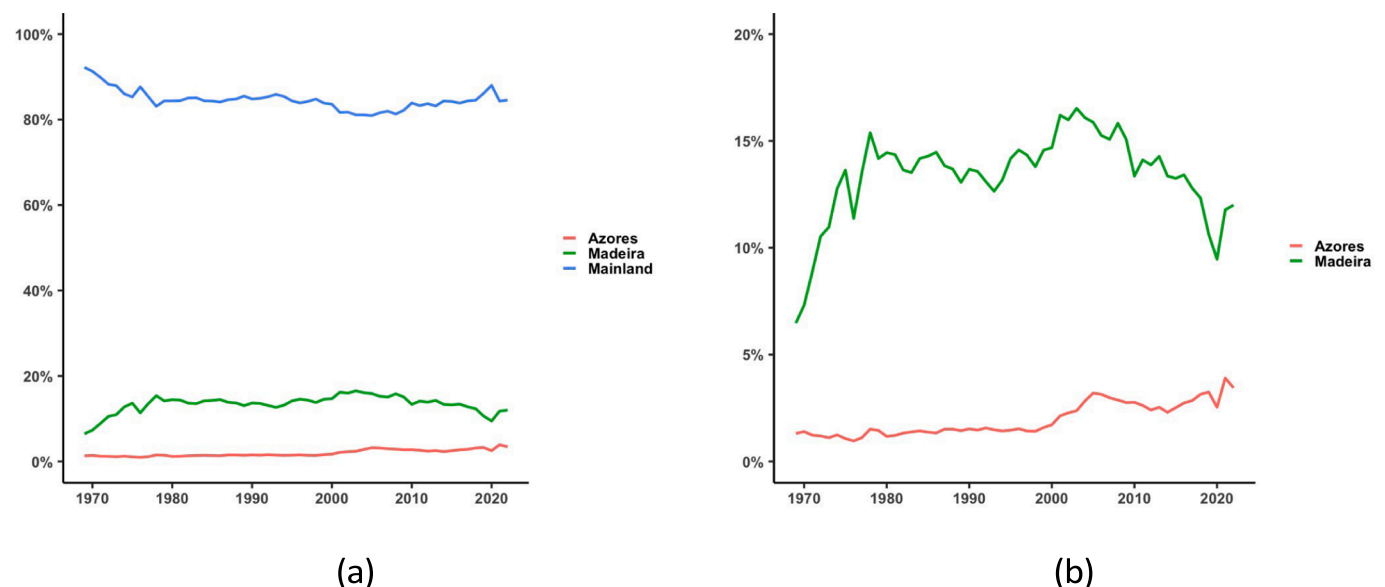
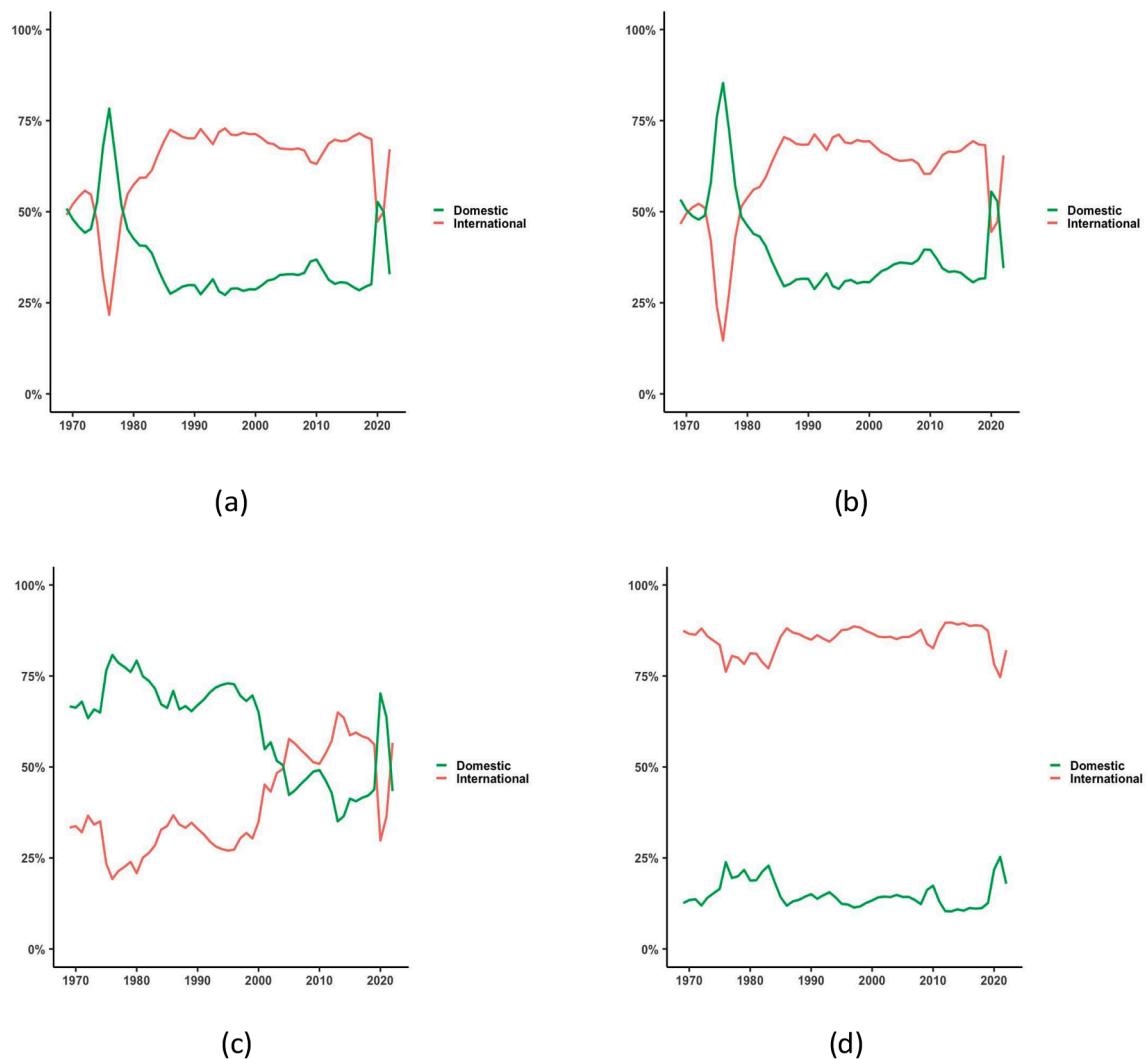


Fig. 5. NUTS I regions' share of the country's number of overnight stays between 1969 and 2022: (a) NUTS I regions. (b) Autonomous Regions.

Table 5

Statistics for NUTS I regions' share of the country's number of overnight stays (%).

Region	1969–2019							2020	2021	2022
	Min	Q_1	Q_2	Mean	Q_3	Max	SD			
Mainland	80.9 (2005) ¹	83.7	84.4	84.6	85.3	92.2 (1969) ¹	2.3	88.0	84.3	84.5
Azores	1.0 (1976) ¹	1.4	1.5	1.9	2.5	3.2 (2019) ¹	0.7	2.5	3.9	3.5
Madeira	6.5 (1969) ¹	13.1	13.8	13.5	14.5	16.5 (2003) ¹	2.0	9.5	11.8	12.0

¹Year in which the value was recorded.**Fig. 6.** Guest type share of the number overnight stays between 1969 and 2022: (a) Portugal. (b) Mainland. (c) Azores. (d) Madeira.

The contribution of each NUTS I region to the country's number of overnight stays between 1969 and 2022 is depicted in Fig. 5, with Subfigure 5b zooming in Subfigure 5a just for the two archipelagos.

As expected, the mainland region is the major contributor to the country's number of overnight stays, with a share between 80.9% and 92.2%. The Madeira's share has been significant throughout the years, with values ranging between 6.5% and 16.5%, whereas the Azores' share quite small, between 1.0% and 3.9%, with this maximum being also recorded in the pandemic year 2021.

In Table 5, we give more statistics for NUTS I regions' share of the country's number of overnight stays between 1969 and 2022.

Finally, Fig. 6 shows the guest type contribution to the number of overnight stays in tourist accommodation establishments between 1969 and 2022 for Portugal and NUTS I regions.

From 1978 to 2019, international guests have been responsible for most of the country's overnight stays. This is also reflected in the number of overnight stays in the mainland territory. For Madeira, international guests have always been the major contributors to the

Table 6

Fitted ARIMA models to the annual number of guests series in the territory.

Region	Order	Estimates	s.e.	$\hat{\sigma}$	AICc	AIC	BIC
Portugal	(1,1,5)	$\hat{\phi}_1 = 0.984$	0.029	422.97	763.64	763.69	777.07
		$\hat{\theta}_1 = -0.328$	0.146				
		$\hat{\theta}_2 = -0.126$	0.153				
		$\hat{\theta}_3 = 0.193$	0.165				
		$\hat{\theta}_4 = 0.089$	0.150				
		$\hat{\theta}_5 = -0.487$	0.123				
Mainland	(1,1,5)	$\hat{\phi}_1 = 0.983$	0.031	396.46	757.58	757.63	771.01
		$\hat{\theta}_1 = -0.448$	0.144				
		$\hat{\theta}_2 = 0.033$	0.151				
		$\hat{\theta}_3 = 0.172$	0.203				
		$\hat{\theta}_4 = 0.107$	0.176				
		$\hat{\theta}_5 = -0.490$	0.169				
Azores	(3,1,1)	$\hat{\phi}_1 = -0.223$	0.141	18.62	445.12	446.23	455.79
		$\hat{\phi}_2 = 0.590$	0.123				
		$\hat{\phi}_3 = 0.396$	0.148				
		$\hat{\theta}_1 = 0.883$	0.083				
Madeira	(0,1,1)	$\hat{\theta}_1 = 0.397$	0.139	55.10	545.19	546.93	552.67
		$\hat{\delta} = 27.208$	10.608				

Table 7

Mean forecasts for 2020–2022 number of guests (in thousands) and expected drops compared with recorded values in the territory (%).

Region	Year	Recorded	Forecast	95% PI (Forecast)	Drop	95% PI (Drop)
Portugal	2020	10 430.6	28 838.0	[28 009.0,29 667.0]	63.8	[62.8,64.8]
	2021	14 462.0	30 122.8	[28 518.8,31 726.7]	52.0	[49.3,54.4]
	2022	26 519.7	31 118.0	[28 704.1,33 532.0]	14.8	[7.6,20.9]
Mainland	2020	9 670.3	26 466.0	[25 689.0,27 243.1]	63.5	[62.4,64.5]
	2021	13 027.8	27 828.7	[26 405.3,29 252.1]	53.2	[50.7,55.5]
	2022	23 914.3	28 898.9	[26 737.5,31 060.2]	17.2	[10.6,23.0]
Azores	2020	238.3	834.8	[798.4,871.3]	71.5	[70.2,72.7]
	2021	501.2	892.8	[822.1,963.5]	43.9	[39.0,48.0]
	2022	825.0	938.4	[834.1,1 042.7]	12.1	[1.1,20.9]
Madeira	2020	552.0	1 459.1	[1 351.1,1 567.1]	62.2	[59.1,64.8]
	2021	933.1	1 486.3	[1 300.8,1 671.8]	37.2	[28.3,44.2]
	2022	1 780.4	1 513.5	[1 274.4,1 752.6]	-17.6 ¹	[-39.7,-1.6]

¹Growth compared with forecast.

archipelago's numbers, while for the Azores, only between 2005 and 2019 a bigger share of this region's number of overnight stays is linked to international guests. However, in 2020 and 2021, domestic guests played again the role of major contributors to each case, except for Madeira. In 2022, bigger shares were once more due to international guests than to domestic guests (Portugal: 67.2%; Mainland: 65.5%; Azores: 56.6%; Madeira: 82.1%).

6.2. Pre-pandemic forecasts for the triennium 2020–2022

To measure some of the impact caused by the pandemic on the number of guests and number of overnight stays, the annual time series observed between 1969 and 2019 are used to forecast their mean values for the period 2020–2022, for the country and each NUTS I region. This will allow us to have an idea of what would have been expected for each year and indicator under normal circumstances, that is, under the assumption that the pandemic had not happened. The forecasts are also used to derive yearly expected growths and for comparison with true values, as means to estimate an expected drop for each year and

indicator, therefore allowing a quantitative impact assessment to be made on both variables. The fitted models to the time series are ARIMA models, which satisfy Eq. (4).

6.2.1. Mean forecasts for the number of guests

In Table 6, we show for each region the fitted ARIMA model, as well as the model's parameters estimates and standard errors (s.e.), the white noise standard deviation estimate (σ) and the AICc value. In Madeira's case a drift parameter (δ) is estimated. Although not used in the model selection stage, the AIC and BIC values are also displayed in Table 6 for each situation.

The annual mean forecasts for the number of guests (in thousands) and respective 95% prediction interval (PI) for each year of the period 2020–2022, along with expected drops estimates compared with true values (in percentage), are given in Table 7.

The fitted ARIMA models, the observed time series and the 95% PIs (gray areas) are also shown in Fig. 7.

In Table 8, the yearly forecast changes for the number of guests for the country and for each NUTS I region, according to the ARIMA models,

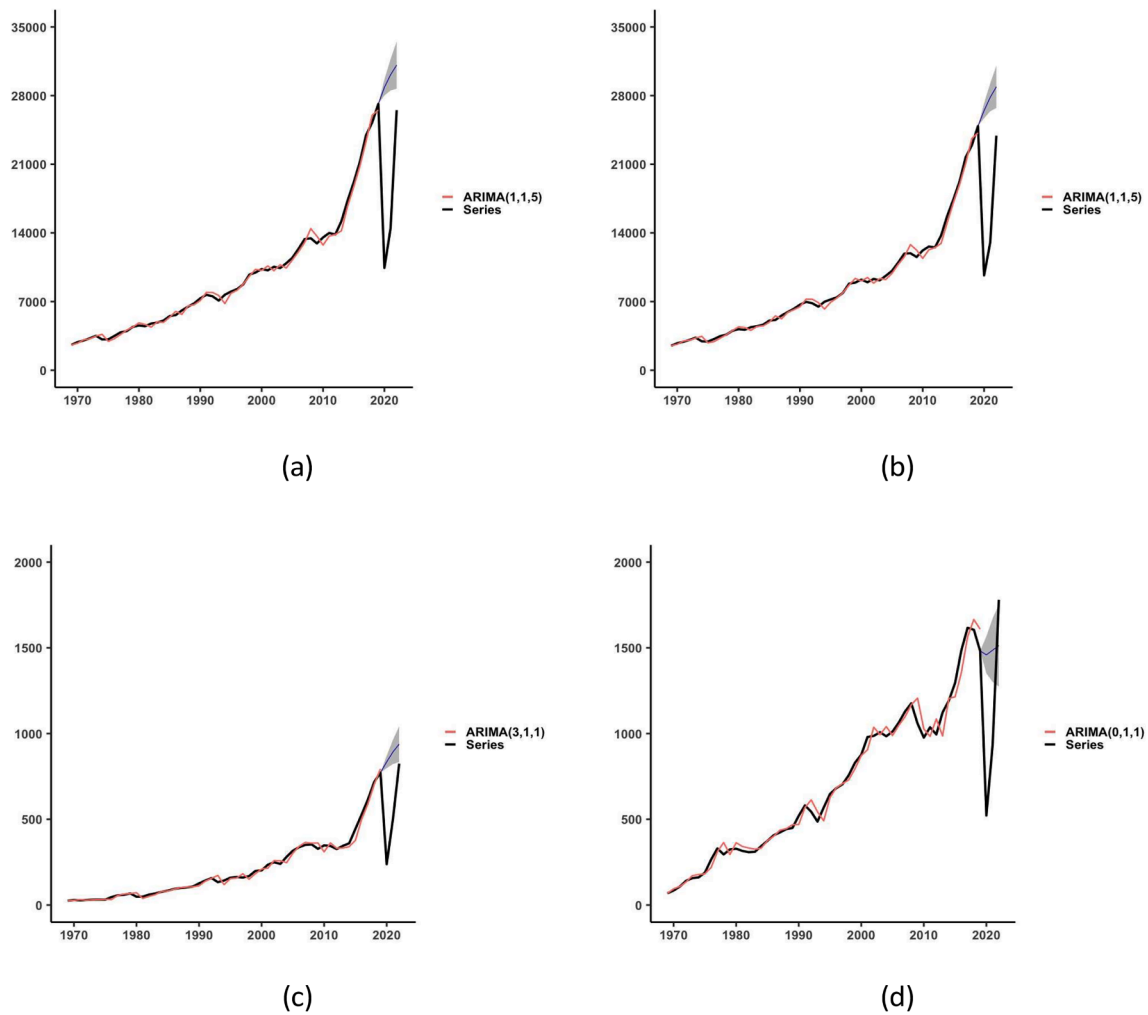


Fig. 7. Fitted ARIMA models and mean forecasts for 2020–2022 number of guests (in thousands), with 95% PIs: (a) Portugal. (b) Mainland. (c) Azores. (d) Madeira.

Table 8

Non-pandemic yearly forecast changes for the number of guests for 2020–2022 in the territory (%).

Region	2020/2019	2021/2020	2022/2021
Portugal	+6.2	+4.5	+3.3
Mainland	+6.3	+5.1	+3.8
Azores	+8.2	+6.9	+5.1
Madeira	−1.6	+1.9	+1.8

are given for 2020–2022, with each year's forecast being compared with the previous year, except for 2019 where the actual recorded value was used for comparison with 2020.

6.2.2. Mean forecasts for the number of overnight stays

Information on the fitted ARIMA models to the annual number of overnight stays series in Portugal and each NUTS I region is given in Table 9. For Madeira's case a drift parameter was again estimated to improve the model's fit.

The annual mean forecasts for the number of overnight stays (in thousands) and associated 95% PIs for 2020–2022, with expected drops estimates compared with true values (in percentage), are indicated in Table 10.

In Fig. 8, the fitted ARIMA models, the observed time series and the 95% PIs are shown.

The yearly forecast changes for the number of overnight stays for the country and for each NUTS I region, according to the ARIMA models, for

the period 2020–2022 are indicated in Table 11.

7. Discussion

According to our forecasts, if the COVID-19 pandemic had not happened, Portugal would be expecting growths in its numbers of guests and overnight stays for each year of the period 2020–2022 (see Tables 8 and 11). The highest growths would be expected for 2020, namely of 6.2% and 4.1%, respectively. Although growths are also forecasted for the country in the following two years, these would however be expected to be smaller than those for 2020. Nevertheless, increases of at most 4.5% in the number of guests and of 1.2% in the number of overnight stays would be expected for 2021 and 2022.

A similar scenario to that of the country would be expected for the main regions. The only exception would be for Madeira for 2020, where falls of 1.6% in the number of guests and of 2.3% in the number of overnight stays would be expected but followed by expected growths in the next two years (under 2.0% for both variables). Notice that both indicators did fall in 2019 in Madeira compared with 2018. On the other hand, the Azores would be Portugal's region expecting to have the highest growths for 2020, an increase of 8.2% in the number of guests and 7.7% in the number of overnight stays compared with 2019. As for mainland Portugal, its figures are generally similar to those seen for the whole country, therefore showing that the overall picture of Portugal is a mere reflection of what is happening in the mainland territory.

With the pandemic hitting harder the economy in its first year, a totally different scenario from what would be expected for 2020 was

Table 9

Fitted ARIMA models to the annual number of overnight stays series in the territory.

Region	Order	Estimates	s.e.	$\hat{\sigma}$	AICc	AIC	BIC
Portugal	(0,1,4)	$\hat{\theta}_1 = 0.667$ $\hat{\theta}_2 = 0.040$ $\hat{\theta}_3 = 0.504$ $\hat{\theta}_4 = 0.584$	0.135 0.127 0.177 0.154	1632.67	892.85	893.96	903.52
Mainland	(0,1,4)	$\hat{\theta}_1 = 0.551$ $\hat{\theta}_2 = 0.067$ $\hat{\theta}_3 = 0.587$ $\hat{\theta}_4 = 0.574$	0.133 0.121 0.172 0.152	1502.86	884.59	885.70	895.26
Azores	(1,1,5)	$\hat{\phi}_1 = 0.608$ $\hat{\theta}_1 = -0.141$ $\hat{\theta}_2 = 0.215$ $\hat{\theta}_3 = 0.567$ $\hat{\theta}_4 = -0.037$ $\hat{\theta}_5 = 0.752$	0.130 0.184 0.134 0.148 0.157 0.161	50.20	556.30	556.34	569.73
Madeira	(0,1,1)	$\hat{\theta}_1 = 0.319$ $\hat{\sigma} = 133.447$	0.156 57.749	317.21	720.17	721.92	727.65

Table 10

Mean forecasts for 2020–2022 number of overnight stays (in thousands) and expected drops compared with recorded values in the territory (%).

Region	Year	Recorded	Forecast	95% PI (Forecast)	Drop	95% PI (Drop)
Portugal	2020	25 798.3	73 018.5	[69 818.5, 76 218.5]	64.7	[63.0, 66.2]
	2021	37 332.4	73 869.7	[67 648.4, 80 091.1]	49.5	[44.8, 53.4]
	2022	69 694.8	73 890.7	[65 610.2, 82 171.2]	5.7	[-7.9, 15.2]
Mainland	2020	22 702.4	63 816.7	[60 871.1, 66 762.3]	64.4	[62.7, 66.0]
	2021	31 480.2	64 724.8	[59 289.8, 70 159.8]	51.4	[46.9, 55.1]
	2022	58 856.2	65 455.1	[58 227.1, 72 683.2]	10.1	[-1.1, 19.0]
Azores	2020	654.4	2 453.2	[2 352.1, 2 554.3]	73.3	[72.2, 74.4]
	2021	1 456.5	2 553.7	[2 373.7, 2 733.8]	43.0	[38.6, 46.7]
	2022	2 458.0	2 646.2	[2 375.8, 2 916.6]	7.1	[-3.5, 15.7]
Madeira	2020	2 441.5	7 283.7	[6 662.0, 7 905.4]	66.5	[63.4, 69.1]
	2021	4 395.8	7 417.1	[6 388.3, 8 446.0]	40.7	[31.2, 48.0]
	2022	8 380.5	7 550.6	[6 235.1, 8 866.1]	-11.0 ¹	[-34.4, 5.5]

¹Growth compared with forecast.

observed. For Portugal's number of guests and number of overnight stays, falls of 61.6% and 63.2% were seen that year, respectively (see Tables 2 and 4). The worst case was however seen for the Azores, with a nearly 70% drop being recorded for both indicators, when our forecasts show that this archipelago would be expecting the best results of all three regions in 2020. One possible explanation for these worse results for the Azores is that its Autonomous Government implemented, especially during the first lockdown that took place between March and June of 2020, more restrictive mobility measures for travelers, residents and non-residents, than the Portuguese Government did in the mainland territory and Madeira's Autonomous Government did in this archipelago. It was mandatory then that all travelers arriving at the Azores quarantined for 14 days at a hotel or at home before they could freely move around. These more drastic measures, believed necessary to prevent the spread of the virus throughout the archipelago's nine islands, most likely drove potential tourists away during the summer, which is peak tourist season in the Azores.

In 2021, second year of the pandemic, Portugal followed the small recovery trend seen globally that year, yet still far from pre-pandemic levels. Even though the country's number of guests grew 38.6% and 44.7% for the number of overnight stays compared with 2020, both

figures are around 53% of pre-pandemic levels. In that same year, the best recovery was seen for the Azores, the total opposite of what happened for this region in 2020. For this archipelago, the number of guests and number of overnight stays more than doubled compared with 2020, followed by Madeira's growth of approximately 80% for both indicators. Curiously, under a non-pandemic picture, the Azores would be, according to our forecasts, the country's region expecting the highest growths in the number of guests and number of overnight stays for 2021, more precisely, increases of 6.9% and 4.1%, respectively.

On the other hand, the better results seen in the Azores and Madeira in 2021 compared with mainland Portugal, can probably be explained by the fact that both archipelagos' Autonomous Governments only allowed travelers to enter their regions with a negative COVID-19 test (paid with each region's budget), with further testing being also mandatory down the line during the stay at predetermined time intervals established by the local health authorities. The implementation of these sanitary rules most likely generated more confidence between tourists, especially from a sanitary point of view, to choose Madeira or the Azores as a tourist destination region of Portugal that year.

As for 2022, Portugal saw an almost complete recovery of pre-pandemics levels, achieving 97.7% and 99.3% of 2019 values for the

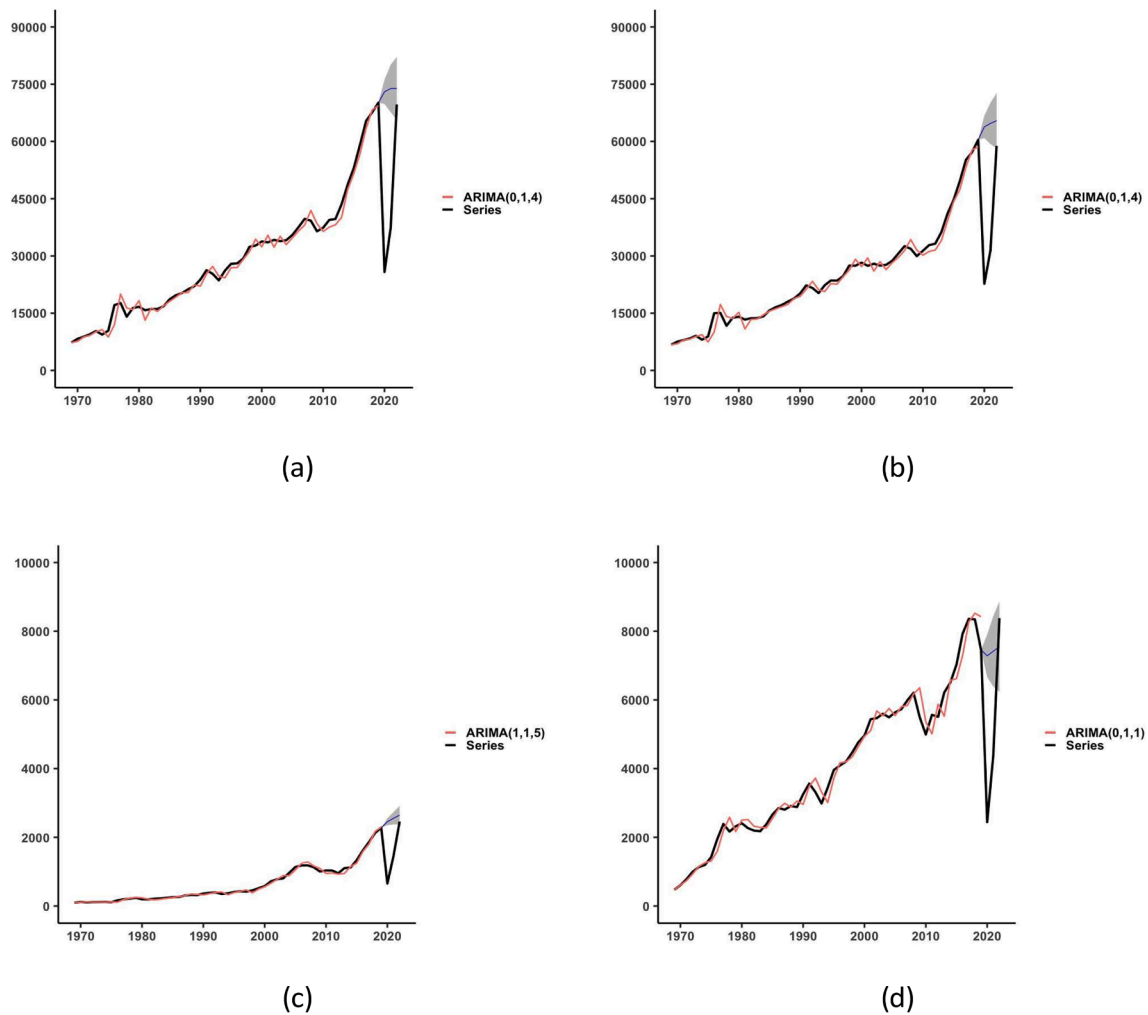


Fig. 8. Fitted ARIMA models and mean forecasts for 2020–2022 number of overnight stays (in thousands), with 95% PIs: (a) Portugal. (b) Mainland. (c) Azores. (d) Madeira.

Table 11

Non-pandemic yearly forecast changes for the number of overnight stays in 2020–2022 in the territory (%).

Region	2020/2019	2021/2020	2022/2021
Portugal	+4.1	+1.2	+0.03
Mainland	+5.6	+1.4	+1.1
Azores	+7.7	+4.1	+3.6
Madeira	−2.3	+1.8	+1.8

number of guests and number of overnight stays, respectively, and seeing growths slightly above 83% compared with 2021 for both indicators. During the pandemic period, 2022 was the best year in terms of global growth, with the only exception being for the Azores since its best results were observed in 2021. Moreover, in 2022, both archipelagos managed to exceed their pre-pandemics levels, with Madeira surpassing the Azores and having an actual growth of 20.1% for the number of guests and 12.4% for the number of overnight stays compared with 2019, as opposed to smaller growths of 6.9% and 7.9%, respectively, for the Azores. Furthermore, in 2022, Madeira and the Azores achieved their best results ever for both indicators.

On the other hand, it is interesting to notice in [Tables 7 and 10](#) that all recorded values for the overnight stays for 2022 are within the 95% PIs and, therefore, may already indicate full recovery of this indicator in that year for the whole country, not just for the two archipelagos.

However, we must bear in mind that this might also not yet be the case, because a bigger prediction error is at play for a three-year forecast than for a two-year or one-year forecast. Concerning the number of guests, neither recorded value is within the prediction range. All true values fell below the PIs lower limits, except for Madeira's 2022 value, which exceeded the upper limit, thus clearly showing a complete recovery of the number of guests for this region in 2022.

When it comes to expected drops, the forecasted falls for Portugal's number of guests and number of overnight stays for 2020 are both slightly above 63%, for 2021 around 50%, and for 2022, 14.8% and 5.7%, respectively (see [Tables 7 and 10](#)). For the two archipelagos the falls are expected to be lower than for the rest of the country in 2021, and are quite similar in their values, nearly a 40% drop. Noticeable smaller expected falls are estimated for 2022 compared with the previous two years. For 2022, the highest expected falls are for mainland Portugal, with a 17.2% drop for the number of guests and 10.1% drop for the number of overnight stays. Of the three main regions, the Azores is the place where the highest expected fall would have happened in the three-year pandemic period, more precisely in 2020, with both forecasts pointing to drops above 71%. Curiously, these expected falls for the Azores are comparable in value with what was seen for this region in 2020 compared with 2019, with the same being said for the other two main regions.

8. Conclusions

At the beginning of the COVID-19 pandemic the tourism sector was undoubtedly one of the economic sectors most affected by its adverse effects, yielding negative consequences to the economies of many countries. Although some signs of recovery were starting to be seen globally in 2021, but even more so in 2022 due to high vaccination rates in several countries, the indicators used to assess the recovery showed that these were still far from pre-pandemic 2019 levels. When looking at data from Portugal, the global trends observed during the pandemic period 2020–2022 were, as expected, being mirrored within to some extent.

Since tourism represents a good slice of Portugal's GDP (15.3% in 2019), we used the annual number of guests and annual number of overnight stays in tourist accommodation establishments to assess the recovery of the hospitality industry, and therefore indirectly of the country's tourism sector. The descriptive analysis of the recorded data show that Portugal has almost managed to “catch up” with its pre-pandemic levels for both indicators above. However, when looking at the data for each main region individually, Madeira and the Azores have managed to exceed their 2019 values in 2022 for both cases.

But to assess correctly whether or not full recovery from COVID-19 occurred in 2020–2022, we compared the recorded values of those two indicators in that period with their corresponding non-pandemic forecasts, derived with ARIMA models. By doing so, we conclude that there is evidence that full recovery has been reached for Portugal in 2022 regarding the number of overnight stays, with the same being said for each NUTS I region individually. As to full recovery of the number of guests, this wasn't yet seen for Portugal in 2022, although this was clearly observed for Madeira that year.

However, a limitation of our study lies on the fact that a recovery assessment of the hospitality sector shouldn't be exclusively based on forecasts for the number of guests and number of overnight stays, and comparisons of these figures with true values. Other variables or indicators should also be taken into consideration. For example, we don't explore how these forecasts are reflected in terms of revenue per available room (RevPAR), which is a performance measure used in the hospitality industry. This would demand a different study (more complex) based on a survey to access information on the total room revenue and number of available rooms (or average daily rate and occupancy rate) during the period 2020–2022.

From a public health perspective, the first two cases of COVID-19 in Portugal were confirmed on March 2, 2020, and since then the number of new cases began to grow rapidly. But after the approval of the first vaccine against COVID-19 by the European Union on December 21, 2020, Portugal was able to successfully organize and implement a mass vaccination program in a very short time, and that was considered an example to be followed by other countries. The success of the Portuguese program was also largely due to the high adherence of the population to the call for vaccination by the health authorities. According to COVID-19 data published by the Ministry of Health, 93% of the Portuguese population were vaccinated against the virus in the first stage of the program (one of the highest coverages in the world), and 67% with at least one vaccine booster. This situation contributed to reducing the number of deaths and more serious illness caused by the virus, but also to allow a faster recovery of the Portuguese economy from the adverse effects of the pandemic.

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Maria de Fátima Brilhante: Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Maria Luísa Rocha:** Investigation, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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