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Supervisor: Tea Baldigara, PhD, Full Professor

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PRIMJENA VEKTORSKIH AUTOREGRESIJSKIH MODELA U TURIZMU: ANALIZA STANJA I BUDUĆI RAZVOJ

DOKTORSKA DISERTACIJA

Opatija, 2022.

SVEUČILIŠTE U RIJECI UNIVERSITY OF RIJEKA
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ABSTRACT

Background: This dissertation is focused on time series analysis and based on several research strategies and methods.

The most frequent methods were presented in the attached scientific articles. Four papers were published in international scientific journals indexed in the Web of Science database. Since tourism is one of the most lagged industries in science, new approaches to time series analysis should be implemented. This research introduces an extension of the time series methodology that focuses on investigating and testing normal distribution of the residuals as a key prerequisite for the adequacy of econometric models. The latter has thus far not been considered in quantitative approaches in tourism and is supported in the fourth attachment (p. 14).

The motivation for the research is multidimensional. Firstly, to filter previous research regarding time series in tourism. Secondly, to develop and redesign time series methodology and methods, theoretically and empirically, for tourism. Both are presented in the second attachment (p. 11–13, 17). Finally, tourism forecasts should be based on reliable models (second paper, p. 14 and fourth paper, p. 15–18). As seen in the most recent shocks, tourism ex-ante prognosis have become critical. This issue has been hypothesised in the dissertation and presented in the first published article (p. 1, 5–6).

Aims: The dissertation aims to research and develop appropriate econometric models capable of capturing specifics of multiple interactions in the tourism market. The research seeks to develop econometric models for Slovenia and Croatia, two countries whose economic development is predominantly based on tourism.

There are four goals and four specific objectives for the research: 1) to introduce an improved time series approach in cointegrated panels. The first specific objective (SO1) is to test at least ten econometric modelling structures that reduce cycle breaks. 2) to examine previous theoretical thinking regarding the cointegration of time series, cross-sectional data, and panels. The second specific objective (SO2) is to outline at least 250 previous empirical studies for the tourism industry. 3) To examine cointegration in tourism data for Slovenia and Croatia. The third objective (SO3) is to model at least three econometric time series equations and mathematical theorems/lemmas for the tourism industry. 4) To improve and better understand unit root tests in tourism. The specific objective (SO4) is to approach the design of at least three stable and innovative models.

Methods: Instead of qualitative subjectification, this research relies upon econometric modelling in time series and panels. Therefore, the latest misspecification tests were implemented. The studies are primarily oriented to the evolving methodological system. In all published articles, steps in the time series methodology are appreciated and further insights are added. All studies use the vector autoregression model (VAR) which is widely used in science.

Additionally, the cointegrated model VAR is applied in the second, third and fourth paper. The first published paper also employs the error correction model (ECM). In the third (p. 746) and last paper (p. 18), Granger causality is used to identify trends in order to determine the direction of hypothesised

research problems. Overall, the study uses regression analysis and summary descriptive statistics. The sensitive analysis relies on panel regression (second paper, p. 17 and the first paper, p. 12). In summary, the added value of the study is to investigate the normal distribution of time series residuals to obtain accurate results for interpretation and prediction, which is presented in the third (p. 738, 742) and fourth (p. 14) paper.

Results and contribution to science: The results are visible in testing and modelling time series and panels based on research hypotheses. The main hypothesis (an innovative approach to cointegration, based on empirical evidence for Slovenia and Croatia, which provides unbiased, accurate and validated results for tourism development) was confirmed in the published scientific papers.

The hypothesis was tested during the research. The first published paper investigates the possibility and accuracy of using time series data in forecasting tourism demands. The theoretical added value provides ex-ante research on the consequences of the recent pandemic (i.e. 2020 – 2022). The empirical part of the first published paper discusses the direction of daily Slovenian and Croatian Covid-19 infections and tourist arrivals. Together with the second paper, the first confirms hypotheses 1 (the tourism industry in Slovenia has developed rapidly and is expected to continue growing in a positive and sustainable direction without seasonal fluctuation) and 2 (the tourism industry in Croatia has a long tradition and opportunity to grow at unprecedented rates. Volatility in the Croatian tourism industry is significant and has a high standard deviation). The second paper introduced the modelling strategy's environmental and ecosystem variables. The results demonstrated considerable influence on tourism demand. Depending on the modelling methodology, those determinants have a specific impact on tourist arrivals.

Nevertheless, the last two papers discussed the direction of economic impacts on tourist arrivals and vice versa. The third paper confirmed the significance of productivity to real gross wages with a rise in tourist arrivals (p. 748). The last paper forecasted prices in tourism based on short-run effects and two cointegrated relations. It can be concluded that tourism demand measured by tourist arrivals is volatile on different determinants, which were previously not researched or tested by a reliable econometric model and vibrant determinants. Therefore, the set goals and specific study objectives were achieved.

Conclusion: Time series approach was developed in the Scandinavian doctoral dissertation. This research provides several outputs: i) systematic analysis of different existing cointegration approaches; process modelling, used models and methods; ii) an applied multi-year data analysis for two countries, iii) a new collection of considered variables, and iv) guidelines and recommendations for tourism researchers and practitioners, e.g. for the development of quantitative models that allow tourism to make reliable conclusions based on secondary quantitative data.

Keywords: Croatia, Econometric analysis, Forecasting, GDP, Secondary Data, Slovenia, Time series, Tourist Arrivals

JEL classification code: C32, C33, C53, C82, Z32

PROŠIRENI SAŽETAK

Problem i predmet istraživanja: Predmet istraživanja rada jest ekonometrijsko modeliranje temeljeno na metodama vremenskih serija. U priloženim znanstvenim člancima prikazane su najčešće korištene metode u istraživanju. Četiri rada objavljena su u časopisima indeksiranima u Web of Science bazi podatka.

S obzirom na izazove koje turistički sektor postavlja u analizi i prognoziranju, potrebno je iznaći nove i efikasnije pristupe analizi vremenskih serija. Disertacija stoga, istražuje inovativni pristup analizi vremenskih serija, s naglaskom na normalnu distribuciju reziduala, kao jednu od temeljnih pretpostavki ekonometrijskoga modeliranja. Navedena problematika dosada nije u dovoljnoj mjeri razmatrana u kvantitativnim analizama, što je i dokazano u četvrtom objavljenom znanstvenom radu (str. 14). Motivi, koji su utjecali na odabir navedenoga područja istraživanja, višestruki su.

Prvi se motiv svakako odnosi na stvaranje detaljnoga pregleda postojećih prethodnih istraživanja iz domene analize i primjene vremenskih serija u istraživanju ključnih determinanti u turizmu. Drugi motiv, a koji proizlazi iz rezultata spomenutoga istraživanja za stolom, očituje se u potrebi za dizajniranjem efikasnijih metoda analize vremenskih serija u teorijskom i empirijskom istraživanju u turizmu; oba motiva su uspješno predstavljena u drugom objavljenom radu (str. 11–13). Tema doktorske disertacije usmjerena je na istraživanje i razvoj odgovarajućih ekonometrijskih modela sposobnih da uoče složenu prirodu te višestruke međuovisnosti odabranih odrednica turističkoga tržišta.

Problem ekonometrijskog modeliranja koji se istražuje u disertaciji svakako je višestruk te je posljedica suvremenih tehnoloških, društvenih i ekonomskih procesa koji utječu na kretanja u suvremenoj turističkoj industriji, čija se efikasna analiza i prognoziranje moraju temeljiti na modelima koji uvažavaju određene nepredvidive pojave. Temeljem navedenoga, u istraživanje su uvedene i implementirane specifične varijable i determinante, koje doprinose efikasnosti kvantitativnih modela temeljenih na analizi vremenskih serija turističke potražnje, ali i rizika prognoziranja turističkih kretanja (drugi rad, str. 14 i četvrti rad, str. 15–18). Prognoziranje u turizmu postalo je bitan procesni čimbenik što je i potvrđeno u nedavnim šokovima od utjecaja na turizam (pandemija, resursi, cijene u ugostiteljstvu, političke nestabilnosti) ovako hipotetizirani problem razmatran je u prvom objavljenom članku (str. 1, 5–6).

Ciljevi doktorske disertacije: Cilj istraživanja je, dakle, inovirati znanstveno promišljanje (analizu, modeliranje i predviđanje ključnih odrednica) turističke industrije utemeljeno na modernim metodama ekonometrijske analize i upotrebi sekundarnih kvantitativnih podataka vremenskih serija kao i podataka vremenskog presjeka. Iz definiranoga problema i postavljenih ciljeva istraživanja postavljena je glavna istraživačka hipoteza kao i pomoćne hipoteze.

Cilj doktorske disertacije može se stoga sažeti kao istraživanje i razvoj odgovarajućih ekonometrijskih modela sposobnih da uoče i obuhvate specifičnosti i složenost višestrukih interakcija prisutnih na suvremenom turističkom tržištu. U tom su smislu dizajnirani i testirani ekonometrijski modeli za Sloveniju i Republiku Hrvatsku, dvije zemlje čiji se gospodarski razvoj temelji na turizmu. Rezultati istraživanja pokazali su kako ne postoji sustavnija analiza vremenska serija i panel ekonometrijske metodologije turizma u obje zemlje. Takvi su zaključi i potvrđeni formalnim suvremenim testovima normalnosti distribucije pogrešaka. Upotreba višestruke regresijske analize pokazala je i potvrdila neadekvatnost primjene navedenih testova u dosadašnjim analizama.

Znanstvene metode: Istraživanje se temelji i razvija na sekundarnim podacima prikupljenim iz eminentnih sekundarnih izvora, kao što su Svjetska banka, Državni zavod za statistiku Republike Hrvatske (DZS), Statistički ured Republike Slovenije (SURS), Statistički ured Europske unije (EUROSTAT) i Statistička baza podataka Ujedinjenih naroda (UN data). Na temelju prikupljenih podataka, ovisno o njihovoj dostupnosti, razvijene su vremenske serije s godišnjim, tromjesečnim, mjesečnim ili dnevnim intervalima, a koje su predstavljale osnovu za ekonometrijskoga modeliranja.

U doktorskoj disertaciji primijenjena metodologija kointegracije u modeliranju kretanja vremenskih serija u turizmu dviju navedenih susjednih zemalja. Primijenjena ekonometrijska analiza pokazuje nedostatak adekvatnog pristupa u području turističke industrije. Stoga je, prvi dio istraživanja posvećen istraživanju opusa postojeće i dostupne literature, ali i prethodnih empirijskih istraživanja u području turističkoga sektora, primjeni odgovarajućih modela i empirijskih rezultata dobivenih gore spomenutim pristupom modeliranju.

Temeljeno, na metodologiji vremenskih serija postavljene su glavna in dvije pomoćne hipoteze. Glavna hipoteza glasi: inovativni pristup kointegraciji, utemeljen na empirijskim podacima za Sloveniju i Republiku Hrvatsku, daje nepristrane, točne i provjerene rezultate koji pozitivno utječu na razvoj turizma. Prva pomoćna hipoteza glasi: turistička industrija u Sloveniji se je brzo razvijala i očekuje se da će nastaviti rasti u pozitivnom i održivom smjeru bez sezonskih fluktuacija. Druga pomoćna hipoteza tematizira kako turistička industrija u Republici Hrvatskoj ima dugu tradiciju i preduvjete bržega rasta i to prema po dosada neostvarenim stopama. Volatilnost u hrvatskoj turističkoj industriji je značajna i ima visoku standardnu devijaciju. Stoga hrvatska turistička industrija nudi izazovno istraživačko pitanje.

Rezultati istraživanja i znanstveni doprinos: U ekonometrijskom modeliranju, prikupljeni kumulativni podaci prikazani su u vremenskim serijama (bruto domaći proizvod, nezaposlenost i inflacija). Osim navedenih primarnih pokazatelja razvoja gospodarstva, razvijene su i proučavane različite vremenske serije (plaće zaposlenika i produktivnost, cijene, dolasci turista, okoliš, zdravstveno stanje pojedinca te broj ostvarenih noćenja turista u dvjema susjednim jadranskim državama članicama Europske unije, odnosno Slovenije i Hrvatske).

Koristeći suvremenu metodologiju kointegracije vremenskih serija i panel podataka, istraživanje je razvijeno u dva smjera: 1) teorijski pristup razvoju kointegracije i ekonometrijskog modela za normalno distribuiranu kointegraciju na uzorku pogreške empirijskog modela, i 2) primjenu adekvatno definiranog modela na sekundarnim podaci za Sloveniju i Republiku Hrvatsku. Korištenjem metode kointegracije i podataka o ključnim determinantama turističke industrije u primijenjenoj ekonometriji, rezultat istraživanja očituje se u predlaganju robusnoga empirijskoga modela predviđanja stanja kretanja pojedinih varijabli, ali i adekvatno razmatranje dobivenih rezultata. Upravo je adekvatno razmatranje rezultata jedan od najvažnijih čimbenika u općoj ekonomiji i važan doprinos znanstvenog proučavanja turističke industrije.

Rezultati istraživanja polučeni u pojedinim objavljenim znanstveno istraživačkim radovima odgovaraju postavljenim hipotezama, ciljevima istraživanja i specifičnim ciljevima zadanim u glavnoj hipotezi istraživanja. Svrha prvog objavljenog znanstvenoga rada bila je definirati utjecaj različitih društvenih determinanti u dviju susjednih država, koje utječu na sezonalnost, a koja se testira i istražuje u hipotezama 1 i 2. Razvoj konzistentnog ekonometrijskog modela primijenjenoga u ovome istraživanju, zajedno sa narednim, sveobuhvatan je i opći znanstveni napredak s ekonometrijskog gledišta i empirijske robusnosti.

U drugom objavljenom znanstvenom radu ispitana je glavna hipoteza i to razvojem inovativnog modela za kointegracijsku analizu. Inovativne varijable uvedene su na temelju intuicije i teorije. Stoga, se pretpostavlja da je razvijen efikasan model predviđanja, a rezultati su nepristrani, točni i validirani u sklopu turističke industrije, ali i šire. Dobiveni rezultati mogu imati signifikantan utjecaj na suvremena društvena i politička kretanja. Stoga su rezultati sadržani u objavljenom znanstvenom radu adekvatni i upućuju na prognoze koje svjedoče o značajnom padu broja dolazaka turista zbog utjecaja prirodnih katastrofa i epidemije. Navedenim su potvrđene hipoteza 1 i 2.

Rezultati trećeg objavljenog znanstvenog rada odnose se na ekonomske determinante produktivnosti i broja dolazaka turista. Uzročne veze između plaća i volatilnosti rada na turističkom tržištu u Republici Hrvatskoj i Sloveniji analizirane su za razdoblje od 21 godine. Rezultat normalno distribuiranoga vremenskoga niza potvrđuje tri kointegrirana prostorna odnosa koja su značajna za glavnu hipotezu. U tom smislu, od presudne je značajnosti bila pretpostavka razumijevanja važnosti ekonometrijskoga modeliranja u jednom od ključnih sektora turizma: zapošljavanju. Stoga se analiza temelji na produktivnosti i odgovarajućoj metodologiji definiranoj od strane autora. Navedenim su potvrđene istraživačke hipoteze 1 i 2.

Polazeći od teorijskog problema $I(2)$ i $I(1)$ integracije cijena i inflacije, razvijena je inovativna metodologija modeliranja koja doprinosi stabilnosti modela. U istraživanje je uključeno veći broj metoda, no u četvrtom objavljenom znanstvenom radu prikazane su tek one najznačajnije. Navedeni znanstveni rad ujedno je i najznačajniji za provedeno istraživanje u disertaciji, s obzirom da teoretski unapređuje područje analize vremenskih serija te dodaje znatnu dodanu vrijednost ekonometrijskoj znanosti. Ocjenjivane su obje zemlje, a glavna konstrukcija modela razvijena je na slovenskim primjerima i podacima o gospodarskim krizama.

Zaključak: Doktorska disertacija, uz četiri objavljena znanstvena rada, prikazuje znanstveno promišljanje turističke industrije (analiza, prezentacija modela i predviđanje ključnih čimbenika) temeljeno na suvremenim metodama ekonometrijske analize i sekundarnim podacima vremenskih serija i vremenskog presjeka. Definirana glavna hipoteza i dvije pomoćne hipoteze dovele su do četiri istraživačka cilja i pomoćna cilja.

Istraživanje je polučilo višestruke rezultate: i) sustavnu analizu različitih postojećih pristupa kointegracije, procesa modeliranja, modela kao i metoda, ii) primijenjenu višegodišnju kvantitativnu analizu podataka za Sloveniju i Republiku Hrvatsku, iii) prikupljanje, rezimiranje i razmatranje varijabli uključenih u analizu i iv) smjernice i preporuke za sve sudionike uključene u turistički sektor, i razvoj kvantitativnih modela koji omogućuju donošenje pravovaljanih odluka temeljenih na analizi sekundarnih kvantitativnih podataka.

Originalnost i inovativnost doktorske disertacije ogledaju se u metodologiji modeliranja vremenskih serija, normalnosti pogrešaka i panel modela. Trendovi sezonskih varijacija rijetki su u makroekonomiji, ali

se mogu pronaći u turizmu. Sa svojim prekidima, model vremenske serije može pružiti adekvatne rezultate, doprinijeti originalnosti i značajnosti ekonometrijske analize u području turizma. Nadalje, istraživanje je pokazalo i kako dizajnirani modeli daju relevantne rezultate prognoziranja, ali i predstavljaju temelje za generiranje novih ideja. Novost provedenoga istraživanja ogleda se u tome što se kroz korištene podatke identificiraju značajni preokreti u turizmu. Ovo istraživanje bi se moglo smatrati polazišnom točkom za praktična razmatranja turističkih odrednica, s obzirom da pruža korisne informacije turističkim poduzećima i njihovom menadžmentu o događajima koji potiču ili ograničavaju poslovanje. Općenito, treba reći da predloženi scenarij predstavlja značajan napredak u ekonometriji i turističkoj industriji kako sa teorijskoga tako i sa empirijskoga gledišta. Zaključno, je potrebno naglasiti kako daljnji proces kvantitativnoga istraživanja u domeni ekonometrije, uključivši umjetnu inteligenciju i analitiku velikih podataka, postaje presudan u budućim analiziranjima turističkoga sektora kada je riječ o kvantitativnoj ekonomiji i ekonometriji.

Ključne riječi: BDP, dolasci turista, ekonometrijska analiza, Hrvatska, predviđanje, sekundarni podaci, Slovenija, vremenske serije

CONTENTS

1. INTRODUCTION

Tourism is an essential component of European economy. It accounts for 5% of the European Union's (EU) gross domestic product (GDP), and its 1.8 million businesses employ 5.2% of the total global workforce. Tourism employs people from diverse backgrounds, both non-profit and profit. In recent decades, the tourism industry has become increasingly informative and relies mainly on the support of agriculture, products, services and information and communication technologies (ICT). As a result, the e-tourism reservation system market is constantly growing. It represents a crucial element of the global tourism market, which in Europe constitutes 36% of the total tourism industry turnover.

1.1 THE PROBLEM AND SUBJECT OF THE THESIS

This research aims to integrate advanced quantitative models and methods seldom used in the tourism industry. Also, to design an appropriate and specifically developed empirical model for quantitative time series econometric analysis to model and predict trends. The novelty of the research is twofold. Firstly, to support and identify the significant disruptions in the tourism industry through analysis of secondary data that feeds into econometric models and sentiment analysis. Secondly, to apply developed models for tourism. The results, seen through time series methodology using the cointegrated vector autoregressive model (CVAR) and its extensions, should provide the basis for decision making and business strategy planning for the tourism industry and theoretically to panel cointegration. This multi-faceted approach should be used as an innovative tool for improving tourism decision-making and business performance.

Nevertheless, there is a significant problem with time series considerations and analysis in science. The data is available in different time intervals: years, months, days or other periods, and the data vector is sometimes short, due to the data collecting frequency. This issue is discussed in the context of the properties of some stochastic processes, the compilation of integration of time series variables and state-of-the-art cointegration.

Testing for cointegration is complex due to the possibility of cointegration and groups of variables (which can be interpreted as cross-sectional cointegration, e.g. Croatia and Slovenia) and within groups. It is also possible that the parameters in the cointegration series and number of cointegration relationships within the panel could be different. It states that the empirical model provides relevant results for predicting or mapping new ideas and approaches. The motivation for the research is thus twofold: first, great interest in time series and the problem of degrees of freedom—secondly, the power of methods that can be applied to the various data processes.

The research problem is dual. The theoretical consists of unifying the idea of cross-sectional, time series and panel data in an innovative theoretical econometric model. Whereas the empirical aims to develop an innovative model applied in tourism to the robustness of data for Slovenia and Croatia. The research directions derived from the formulated research problem were as follows: firstly, the implementation of a well-defined empirical model in the tourism industry, and secondly, the investigation and analysis of the validity of models used in previous researches (literature review). Finally, application of significant econometric models, modelling procedures and methods in applied economics of the tourism industry based on normalities in cointegration for Slovenia and Croatia.

1.2 RESEARCH HYPOTHESES OF DOCTORAL THESIS'

Tourism is the dominant economic sector in Croatia. The cointegrated econometric model for Slovenia and Croatia should help to guide future development in strategic economic decisions. Therefore, there is a need for improved empirical models based on quantitative tourism analysis. Based on the defined research problem, the main research hypothesis is developed:

An innovative approach to cointegration, based on empirical evidence for Slovenia and Croatia, provides unbiased, accurate and validated results for tourism development.

The leading hypothesis concerns the implementation of an applied econometric approach. Appropriate steps must be undertaken for normally distributed residuals of variables within cointegration, based on the known theoretical considerations. The outcome of the modelling process is a test of data robustness in tourism. The sturdiness of Slovenia and Croatia is analysed using two hypotheses, followed by the main research hypothesis and several methodological steps. Whilst studying the selected variables, there was evidence of i) strong correlation, ii) residuals are not normally distributed, and iii) the ordinary least squares (OLS) model for time series has low predictive power, high statistical significance and a high adjusted deterministic coefficient (Kulendran, & Witt, 2001). Thus the hypotheses are:

H1: The tourism industry in Slovenia has developed rapidly and is expected to continue growing in a positive and sustainable direction without seasonal fluctuations.

H2: The tourism industry in Croatia has a long tradition and the opportunity to develop at unprecedented rates hitherto. Volatility in the Croatian tourism industry is significant and has a high standard deviation. This status is an opportunity for positive and more productive growth. Therefore, the Croatian tourism industry offers a challenging research question focusing on a strategic time series approach.

The hypotheses are developed theoretically and empirically tested using innovative and modern methods. Moreover, the normality of residuals has been counterpart, while variables within cointegration could be backward and inappropriate. The methodology is developed, tested and confirmed within the dissertation research aims.

1.3 PURPOSE AND AIMS OF THE THESIS

The econometric methodology has made significant developments in recent years. The purpose of the dissertation is designed based on the prerequisite that tourism is looking for validated econometric analysis. Therefore, quantitative research became crucial. All fields of the economy use time series as a contemporary research methodology, while data contains numerous information. The main conformance of the researcher is to isolate the information from the data, whereas the decisive variables are of great importance. This crucial recognition, accompanied by the contemporary methodology, leads to a better understanding of tourism development. Preventing seasonalities and shocks in tourism could be purposeful by different determinants. Those determinants have been studied in this research.

The motivation of the research is multifarious. Firstly, to filter previous research on time series in tourism. Secondly, to develop time series methods to be used in tourism, theoretically and empirically; both are successfully presented in the second attached paper (p. 11–13, 17). Lastly, forecasts in tourism are performed based on reliable models (second paper, p. 14 and fourth paper, p. 15–18). As seen from recent shocks, tourism's ex-ante prognosis has become critical. This issue has been hypothesised in the dissertation and presented in the first published article (p. 1, 5–6).

When considering the above dissertation research, there are four possible goals when integrating two Adriatic countries. The objectives of the study are multidirectional and listed below.

First, to introduce an improved time series approach in cointegrated panels. The first specific objective (SO1) is to test at least ten econometric modelling structures that reduce cycle breaks. Objective 1: Implementing strategic logic and testing simple methods like OLS and regression analysis. This is due to checking the strength of the proposed econometric model.

Second, to examine previous theoretical thinking on the cointegration of time series, cross-sectional data and panels. The second specific objective (SO2) is to overview at least 250 previous empirical studies and researches on the tourism industry. Objective 2: There are no meaningful empirical models for the tourism industry in applied researches, especially on cointegration. In this stage, an overview of the literature review is provided. The study aims to compile a list of crucial tourism indicators and performance measures that need to be analysed in the tourism industry to predict overcoming events (low season, high season demand, holidays, sustainability), cycles, and economic shocks.

Third, to examine cointegration in tourism data for Slovenia and Croatia. The third objective (SO3) is to model at least three econometric time series equations and mathematical theorems/lemmas for the tourism industry. Objective 3: The aim is to predict future economic performance and enable better planning and forecasting in the European tourism industry. The prevailing idea is that the long term deviation of trends is helpful for understanding the past views of macroeconomic promotion and tourism within the economy. Such long term views indicate an imbalance in the fundamental economic structures and are likely to be informative in identifying the adoption of economic policies and management in conjunction with other changes. Thus it is necessary to examine both long-term data trends and deviations from these trends. The CVAR model is introduced to study Slovenian and Croatian time series data features. Countries such as Slovenia and Croatia are inadequately researched in the tourism industry based on time series data and, therefore, along with SO1 and SO4, are suitable for the current research questions.

Finally, the fourth specific objective (SO4) is introduced to better understand unit root tests in tourism. At least three stable and innovative models will be designed and analysed using time series data in software such as OxMetrics (formerly CATS for RATS) and EViews. Objective 4 is to create/implement a simple model or outcomes for policymakers or practitioners to expect cycles.

2. LITERATURE REVIEW

Part of the dissertation results from detailed and exhaustive desk research of the previous literature dealing with tourism modelling (Eadington, & Redman, 1991). A considerable number (more than 320) of previous empirical and theoretical analyses have been desk-checked in four published articles. In addition, the dissertation describes two sections: 1) modelling process of models and 2) applied evaluation of empirical models in the tourism industry. Therefore, previous researches were grouped into those dealing with modelling processes and those with a pronounced empirical note.

2.1 THEORETICAL STUDIES

First, many authors have discussed the theoretical issue of cointegration, e.g. Brooks (2014). There are several possible steps to generalise the cross-sectional cointegration process. Most previous studies are of the Engle-Granger type, which continues the preliminary work of Pedroni (1999; 2004). Kao (1999) develops a restricted version of the Padroni approach in which the slope parameters are to be determined GroupWise, although the derivatives may still be different. Moreover, the Dickey-Fuller or Augmented Dickey-Fuller (ADF) test regression is performed on a pooled sample assuming homogeneity of the value of the lag length ρ. These restrictions allow for some simplification of the testing approach.

In addition to testing the cointegration of the residuals with these extensions of Engle and Granger (Borozan, 2011), it is possible, albeit more complex, to apply a generalisation of the Johansen technique Larsson et al. (2008). This study is a kind of replacement for each group of assortments separately, combining the values of significance for the trace test and then doubling the sum of their logarithms. An entire approach based on vector autoregression (VAR) is possible but with considerable additional complexity. A VAR model is included and later integrated into the cross-sectional cointegration. Johansen (2019) and Juselius (2017) made significant progress on VAR, unit roots and time series tests. This research aims to extend this issue further.

Kunst and Franses (2011) addressed the problem of testing seasonal roots in monthly data. To this end, they generalise the quarterly Hylleberg – Engle-Granger – Yoo (CHEGY) cross-sectional test. This parametric test contrasts with a new nonparametric test, a panel test instead of a single unit notation – the seasonal unit root test (RURS), which is based on counting extremes in time series. All methods are applied to an empirical dataset on tourism in the Austrian provinces. The strength properties of the tests are evaluated in simulation experiments adapted to the tourism data.

Tran (2014) discussed tourism development in Northeast Asia. Whereas few studies use time series to analyse competition among destinations. In this study, the VAR, vector (V) error correction model (ECM) and Granger analysis are used to examine the causal short and long term effects of tourism in China and Japan on destinations in Northeast Asia. The results show that neither China nor Japan have a short-run impact on tourism development. Interestingly, China's inbound tourism depends on Japan's inbound tourism in the long run, but not vice versa. The study also indicated that Japan has a zero-sum strategy with China to boost tourism and the Japanese economy.

Nonetheless, modelling dynamics in tourism are further developments in the research of Archontakis and Mosconi (2021) using the second-order integration $I(2)$ cointegration model, which has been statistically available since the early 1990s but not widely used empirically (Juselius, 2009; Kongsted, 2005). According to Juselius (2009), the methodology is used in a cointegration process and interaction that Johansen and Juselius's idea (Archontakis & Mosconi 2021) selects the top of the methodology econometrics. The thesis research aims to provide a step-by-step procedure and process for integrating all the accepted methodological steps to obtain a reliable statistical model that could give an applied modern predictive econometric model that is applicable in economics. Nevertheless, several authors have identified misspecification in econometric time series modelling (Gjelsvik et al., 2020), such as statistical inference (Trafimow, 2019), shocks (Pollock, 2020) or incorrect variable selection (Błażejowski et al., 2020). Therefore, the thesis research aims to integrate the chosen order $I(d)$ step with tourism prices, which play an essential economic role in any industrial or financial system.

Finally, Gričar and Baldigara (2019) addressed the need for contemporary theoretical modelling in the tourism industry. A comparative econometric analysis for two neighbouring Adriatic countries is presented. The paper's econometric modelling and purpose are applied to the Jarque-Bera normality test. This approach goes a step further than previous empirical studies that omitted normalities. The effectiveness of the results is the validity of the research findings and their comprehensive dialogue. The discussion closes a path in tourism when conducting a comparative analysis between two neighbouring countries. The exact differences are significant when both developed countries are compared.

Nevertheless, Croatia has higher peaks (min and max), so no specific cointegration was found or created. Based on a reliable econometric model with a low F-statistical test and no spurious results due to a high deterministic coefficient, inflation has no direct impact on the prices of accommodation services. In contrast to Slovenia, this is an important finding for the period of higher inflation rates that will most likely occur in the following years, from 2021, after the pandemic(s) period (pulling and pushing effects) (Gričar & Baldigara, 2019).

2.2 EMPIRICAL STUDIES

Second, following the most crucial research dealing with applied valuation, Marinčič (2018) discussed the application of business cycles, macroeconomic trends, and planning in Slovenian railways considering linear Solow growth theory. Gričar and Bojnec (2018) used time series data to study the causalities of prices in an Adriatic country in recent history.

Nontheless, Gričar and Bojnec (2019) provided a decent econometric model of the time series of short-term accommodation prices and nights spent in an EU country. By addressing the property of some stochastic processes, the cointegrated VAR identifies the problem of incorrect model assumptions. The yo-yo effect is reshaped by adding deterministic variables for long-running protection. The result suggested that overnight stays by foreign tourists are positively associated with short-term accommodation prices. The grain is the data vector and its levies, while a longer one yields differential benefits. The results can help policymakers to set prices based on seasonal volatility. Volatility in the time series of prices provides practical evidence for setting seasonal pricing regimes. Tourists could benefit from the perfectionism of tourism management without violating seasonal price regimes, which are essential towards a destinations appeal. Some significant theoretical and empirical results of Gričar and Bojnec (2019) are as follows. First, testing in CVAR proposes to determine the order of integration for all variables included in the investigation. The decision on the second order of integration for a time series was imposed. Second, second-order integration $I(2)$ is a measure to obtain the point of differentiated variables and check whether a deviation of inflation sets normality in the model. This development was tested, and the result was that inflation measured in the consumer price index plays a crucial role in normalities. Third, the result shows several shocks and breaks in the data. Therefore, proof of the equations is provided by empirical tests on Slovenian data.

Some other research further treats the observed problem/topic. Gričar et al. (2019) studied the relationship between unemployment, GDP and small and medium-sized enterprises (SMEs) that are essential for tourism. The main findings confirm that there are twice as many small and medium-sized businesses (SMEs) in Slovenia as in Croatia. However, Croatia also has twice as many inhabitants. Therefore, the challenges of SME promotion in times of prosperity are immense. Secondly, the exact macroeconomic conditions lead to different entrepreneurial steps and decisions in the studied countries. A two-way causality between GDP growth and the number of entrepreneurs in Slovenia is studied and confirmed. In Slovenia, unemployment is associated with SMEs.

Further, the result for Croatia does not establish a causal relationship. Finally, a cointegration relationship was found for Croatia. The econometric analysis uses three variables in the crisis period from 2008 to 2017: i) number of SMEs, ii) unemployment rate and iii) GDP growth. The data is not deseasonalised. The primary regression analysis contradicts results with a high deterministic coefficient and F-test. The causality between unemployment rates and enterpreneurs has a persistent positive effect (Gričar et al., 2019).

Broadly speaking from an economic perspective, the number of tourist arrivals and overnight stays determine the importance of tourism to a country. Brochado et al. (2017) state that tourist arrivals and tourist experiences are achieved in the hospitality industry. The hospitality industry plays an increasingly important role in the national (Marrocu & Paci, 2013) and global tourism industry (Radojevic et al., 2015) with a classification system for accommodation. Tourists spending money on: shopping, lodging, meals, transfers, sightseeing and recreation all contribute to increasing GDP in developing and developed countries (Chatzimichael & Liasidou, 2019). Increasing GDP creates jobs, generates income and provides opportunities for society to progress (Chen et al., 2017). Governments encourage the development of international tourism while it positively impacts economic expansion, public investment, and progress (Brida et al., 2016). Juselius (2009) advocates raising the prices of non-tradable goods (tourism) in poorer Eastern European countries to compete with richer Western European countries.

It should be noted that previous studies on the tourism industry from a multi-country perspective in cointegration are rare (Zheng et al., 2020; Lee et al., 2016). Bukenya and Labys (2005) claim that despite improvements in communication technologies and the globalisation of economies, observed outcomes have not supported the convergence of commodity prices in spatially dispersed markets from 1930 to 1998. Moreover, Tang et al. (2019) propose a hedonic peer-to-peer (P2P) spatial pricing model. Significant factors affect P2P spatial prices and structural determinants also affect costs.

Balaguer and Pernias (2013) analysed the spatial tourism industry in Spain. Balaguer and Pernias (2013) suggest that forecasts derived from the traditional monopoly technique lead to lower average and dispersion of local prices when there are many competitors. They found evidence that the impact of regional distribution of average prices is more negligible, especially at the end of the week. As a result, there is more exchange in hotel locations for tourists than for business travellers within the urban area. Falk and Lin (2018) explain similar results.

In conclusion, the spatial product market integration problem (Vasiliadis & Kobotis, 1999; Marrocu & Paci, 2013) assumes that there is n variability and volatility in tourism market variables (where n is large). To estimate a model, the formation should be imposed on research determinants. The choice of structure to enforce differentiated tourism markets varies from study to study (Riddington, 2002). A few general models address this research question (Mitra, 2019; Pinkse et al., 2002). Most applied models for dispersed product markets belong to the agriculture and food sector (Bakucs et al., 2015, p. 172). Spatial integration models within the manufacturing literature are located in a discrete selection of structures or relational fields between tourism and agricultural perspectives (Balaguer & Pernias, 2013). Pinkse et al. (2002) assume that their findings on competition in the oil market are minimal. One research hypothesis assumes that each neighbour competes directly on prices. Chatziantoniou et al. (2013) found that oil shocks do not have a lagged effect but affect inflation. Oil shocks also indirectly affect economic development (Sinclair, 1998), while Gričar et al. (2021) recognise the transmission price effect between non-neighbour countries.

3. METHODOLOGY

The performed research provides several outputs: i) systematic analysis of different existing cointegration approaches; process modelling, models and methods used; ii) an applied multi-year, quarterly and monthly data analysis for two countries, iii) collection and analysis of the variables considered and iv) guidelines and recommendations for tourism, i.e. for the development of quantitative models that would allow tourism to make reliable modelling and conclusions based on secondary quantitative data.

One could say that there are two different theses in the development of science scenarios about time series: The American and the European. Therefore, the contribution to the named science scenarios in this research is of great importance. The results of this research can be summarized in increasing tests and modelling in cointegration. The principal methodology and outputs of the hypotheses tested are presented in Table 1, where a defined problem and developed model are presented.

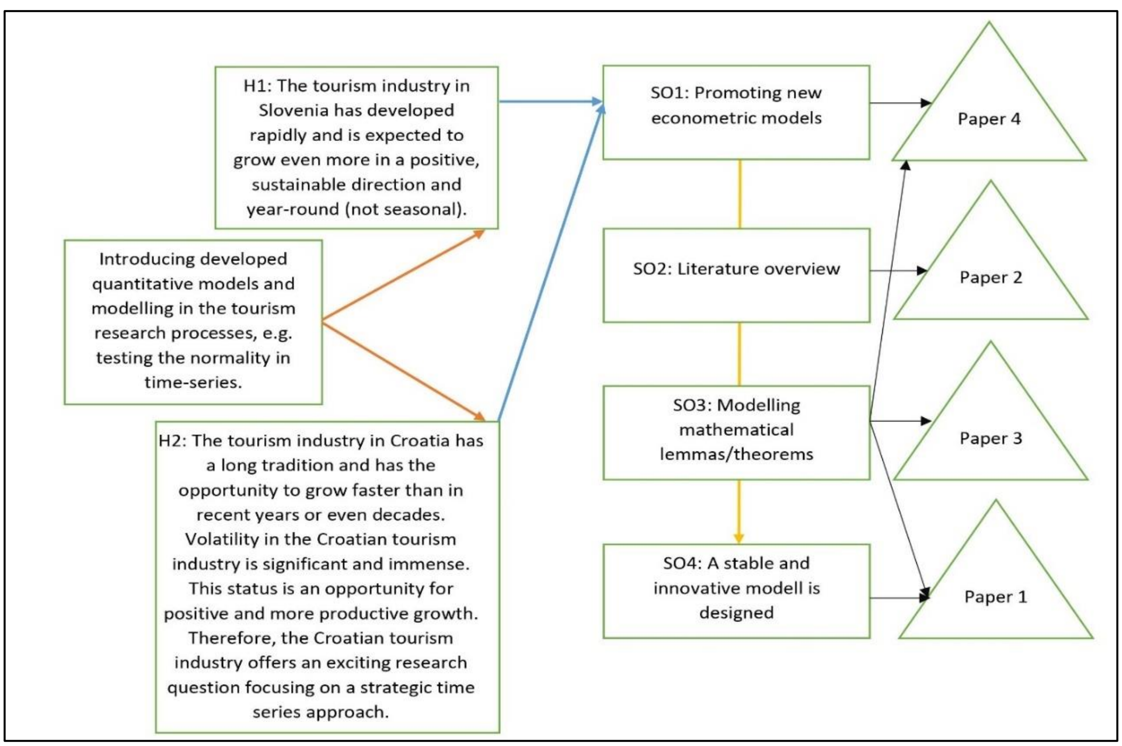
Table 1. Review of the methodology used in the attached scientific papers

Number of the paper	Geographical area and unit included in research	Data frequency and period covered	Model / method	Sample size (T)
1.	Croatia, Slovenia; positive Covid-19 cases, tourist arrivals	Daily; 2020	VAR, Cointegrated regression	286
2.	Croatia, Slovenia; tourist arrivals, environment	Monthly; 1999 – 2021	VAR, CVAR, Sentiment analysis and Sensitive analysis on a panel	256
3.	Croatia, Slovenia; tourist arrivals, employment	Monthly; 1999 – 2020	Cointegration of time series on panels, Granger Causality, VECM, VAR	242
4.	Slovenia, inflation, prices	Monthly; 2000 – 2017	I(1) modelling, forecasting	216

Source: Own source, 2022.

Moreover, Figure 1 discusses the objectives figured in the research based on the main hypothesis.

Figure 1. Overview of the hypotheses and specific objectives



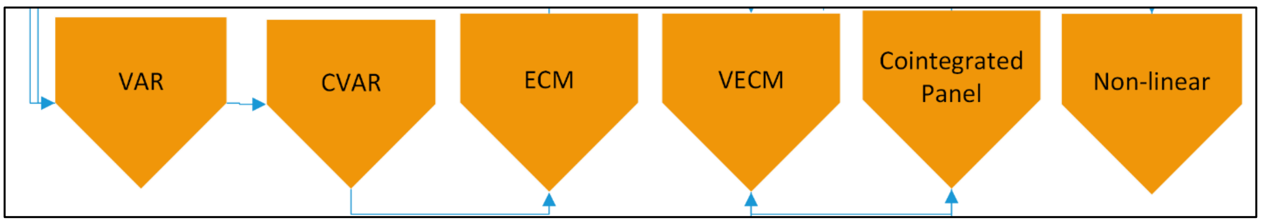
Source: Own source, 2022.

An innovative approach to cointegration based on empirical evidence for Slovenia and Croatia provides unbiased, accurate and validated results for tourism development. A detailed description of the methodology can be found in the attached scientific papers and the following two sections.

3.1 TIME SERIES METHODOLOGY AND NORMALITY

In the recent decade, time series methodology (Figure 2) and panels are the two most developing methodologies in econometrics. Functionally, it has been considered that normality has been widely omitted, skipped, neglected, abandoned and avoided by almost all scholars.

Figure 2. Methodology in time series



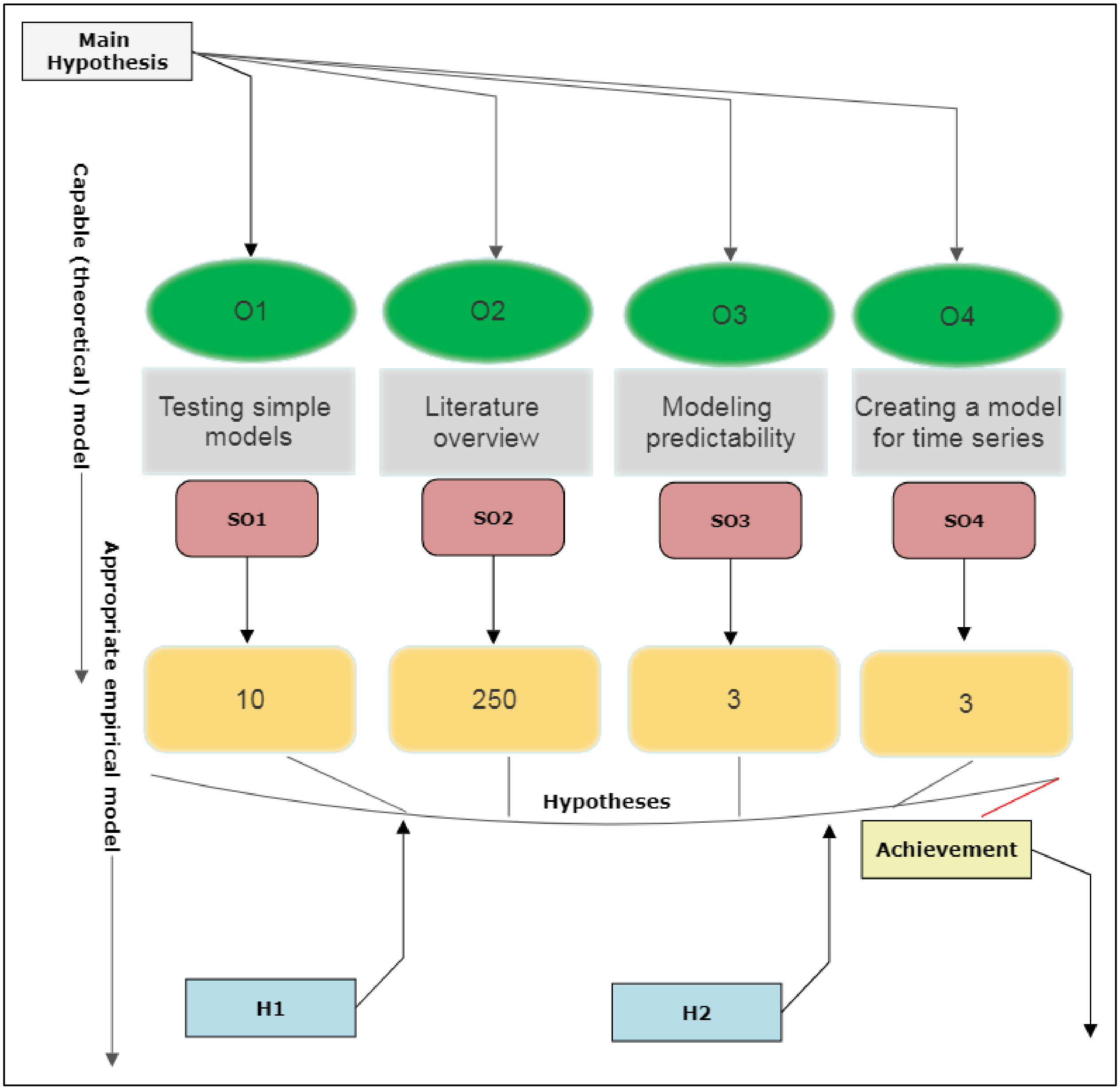
Source: Own source, 2022.

Therefore, the methodology part of the thesis and its objectives have been reformed in this section. Simultaneously, the theoretical and empirical research results have been published in the attached four scientific papers. All contain the methodology step where the normality has been detected and discussed; moreover, in a vast majority of them, the normality has been identified, overdone and widely investigated in theoretical and empirical paths. This gap is researched, and the main contribution of the thesis, defined by the main hypothesis, four specific objectives, and four research objectives, is presented in Figure 3.

In Figure 3, we discuss four objectives (green), aims (grey), specific objectives (numeric – yellow) and hypotheses. Additionally, the highlight is the model specification which should be done for the necessary condition for nominal-to-real data transformation, already discussed by Kongsted (2005) and Juselius (2009). Nevertheless, all aforementioned processes and step diagrams defined in Figure 2 are presented in the results section, e.g., the published articles explaining the research thesis results, hypothesis and objectives.

Therefore, several econometric methods are presented in this thesis. First, regression analysis and descriptive statistics are created in empirical modelling to give a set of observations and highlight the information as simply as possible. Regression analysis contains many lemmas and ideas to distinguish several variables in relationships between the regressed variable and one or more regressors. Second, we hypothesise that the variables, or their residuals in a time series, have a unit root. This implies the non-stationarity of the residuals. The unit root test provides a more accurate approach to the tourism industry for the data obtained. An analysis is based on hypotheses H1 and H2.

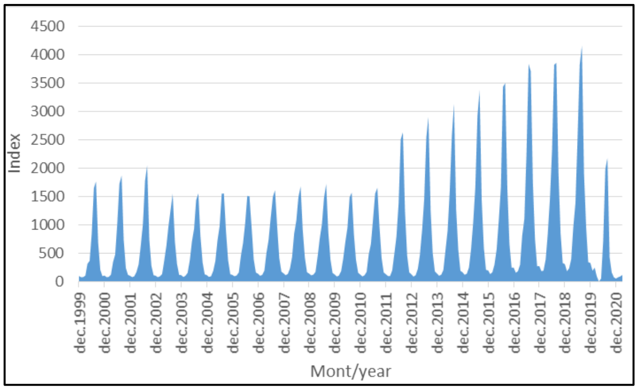
Figure 3. Steps of dealing with the problem in time series research



Source: Own source, 2022.

Therefore, all individual effects are ignored. As a result, many basic assumptions are violated. Fourth, ordinary least squares (OLS) do not account for heteroscedasticity and do not address autocorrelation. Before the latter, advanced econometric solutions need to be implemented, as shown in Figure 2. Overall, the methodology used is summarised in Table 1. Also, second-order integration $I(2)$ time series prediction and panel cointegration is performed. As a starting point, the number of tourist arrivals is considered in Figure 4 and Figure 5.

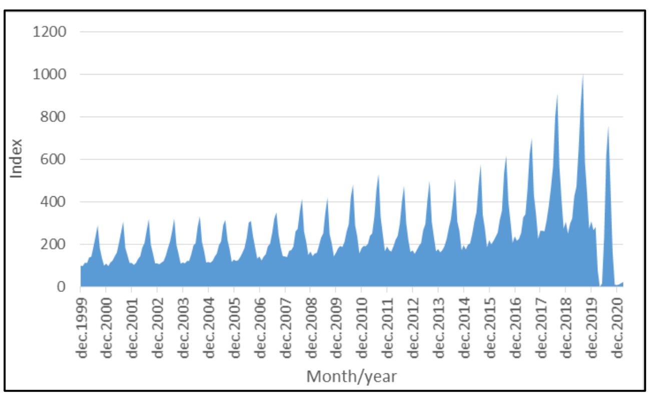
Figure 4. Tourist arrivals in Croatia: December 1999 to December 2020, base index (1999=100)



Source: Authors calculations based on the data from Eurostat.

The thesis's methodology and main research results are discussed in the following sections. First, model recognition is performed, and the used method is described. The proposed theoretical idea forms the focus of all published articles. Different variables are used in the attached papers in different relationships. The time series data set differs depending on the period studied. For the seasonally unadjusted time series data, the likelihood approach recommends careful specification of variables' integration and cointegration effects in systems of equations. Multiple variables were integrated, explaining the long-run cointegration relationships (Johansen & Juselius, 1994).

Figure 5. Tourist arrivals in Slovenia: December 1999 to December 2020, base index (1999=100)



Source: Authors calculations based on the data from Eurostat.

The formal misspecification tests in the published articles (first paper, p. 11; second paper, p. 12; paper three, p. 743; paper fourth, p. 8, 9) confirm that the models have autocorrelations and heteroskedasticity in the residuals. Additionally, the non-normality tests are supported by skewness and kurtosis of the standardised estimated errors. The null hypothesis of normality is not rejected, while the sense of the model derives from the conclusion that some dummies are needed, the most obvious being permanent dummies when visually inspecting the model VAR (paper three, p. 744). The unrestricted model of VAR has various lags, mainly two, and specified ranks that derive eigenvalues using trace or so-called Johansen tests. In the restricted model, there are possible non-weak exogenous variables. The definition of being driven is acknowledged by normalising the beta coefficient for the variables in a long-run relationship in the cointegration equation. A test for the beta restrictions $\tilde{\beta}_1$ in VAR model was also applied. Such a literature-valid VAR scenario can bridge the theoretical model and VAR and results from the mandatory data conditions to make the model empirically consistent (Juselius, 2021).

3.2 ESTIMATION OF A COINTEGRATION

The two analysed countries were exiting former Yugoslavia. The transition took place on three different levels. First, the growth symbolises evolution from a socialist to market economy. The second is the change from regional to national economy. Third, the reorganisation of Yugoslavia's position vis-à-vis the EU and the Economic and Monetary Union (EMU). It is instructive to analyse the time evolution of the indices in the estimated period. During this period, there were several attempts to identify seasonality. Solid evidence of (near) roots and (structural) breaks in time series variables and correlations suggest that economic behaviour is often uncertain. Clement and Hendry (1999) demonstrated that predictions of constant parameter theory models assumed to be correct a priori are unlikely to come true in such a nonstationary ideology. Since rational expectations models represent economic factors that can recursively predict future outcomes with known probabilities, they are inconsistent with structural breaks in the data (Hendry and Mizon, 1993). Therefore, it is unconvincing that these models often have difficulties describing time series data. The widespread nonstationarity in econometrics is evidence of the uncertainty of the future direction of the series.

The number of observations, mean and median values and maximum and minimum values for scaling two cross-sectional time series into levels are introduced. At the same time, it is checked whether the distribution of indices for the level, which corresponds to a normal distribution, is correct. Based on the skewness and kurtosis of the distribution of the time series, and according to their level, they argue that it is a significant non-asymmetric distribution in most possible cases. The residual tests of the models for misspecification show that zero normality, no autocorrelation, and no autoregressive conditional heteroskedasticity (ARCH) were rejected for the results of the hypothesis tests. Thus, the first set of diagnostic tests showed clear nonconformity with the assumed distributional assumptions. Accordingly, some models are not correctly determined; the reported statistical inference is not maximum likelihood and the p-values calculated from the standard normal distributions (t; F, and χ^2) may be completely unreliable. In particular, the assumption that the data are stationary when they are very close to stationarity is probably not appropriate for all inferences about dynamic approximations (Johansen, 2012).

The assumption of stationarity required for log-linearisation around constant stationary rates can be estimated from the calculations of the characteristic roots of the model (Haavelmo, 1950). It turns out that a root of 1.000 is identical to a unit root. Even a root of 0.94 is nearly unity, suggesting an additional source of distinct persistence in the data. However, there is a simple solution to the problem in data unit roots and their impact on conclusions. Again, the standard consideration would be to convert the data into stationary components through differencing and cointegration (Juselius, 2009). This is also the most appropriate solution for the models included. Note that $(y_t - x_t, \dots) \sim I(1)$ implies $(\Delta y_t - \Delta x_t, \dots)$ long-term homogeneity implies cointegration between variable differences. If this is the case, then the stochastic trend can be viewed similar to the stochastic growth trend (Juselius, 2009). In an exemplary process, it is of great use to classify variables that exhibit a high degree of stability over time (the non-significant mean version) as nonstationary and variables that demonstrate a significant tendency to reverse as stationary. Nonetheless, it is essential to emphasise that stationary/nonstationary or the developed synthesis of a variable is generally not a summary of a variable from secondary sources but rather an available econometric approximation for distinguishing short-, medium-, and long-run variation in the data (Juselius, 2009).

Finally, it is necessary to illustrate that a similar stochastic process can adequately describe the data. The Slovenian and Croatian time series were plotted at levels and differences. Overall, all the different variables in the time series show the same as the stochastic process. They assume that the variables are $I(1)$, so the nominal data vector could be converted into real ones. Real variables look similar and are nonstationary. The data set is used in academic papers to illustrate many empirical results. The data vectors are of the form

$$[y_{1\,\underset{i\,j}{t}} y_{2\,\underset{i\,j}{t}} y_{n\,\underset{i\,j}{t}}], t = year{:}month, \dots, T; T = 1, 2, \dots N, \tag{1}$$

they are supported by plots of the data in levels and first differences. Visual inspection shows that the assumption of an average constant does not seem to be an appropriate variables level, whilst the data is more diverse. The premise of constant variance is more difficult to estimate based on the data in levels. Summers (1991) echoes this idea by claiming that the less-than-administrative study of empirical facts generally provides a path to more advanced econometric studies. However, similar assumptions are too crude and may even be wrong when data is nonstationary, whilst typical correlation coefficients and average growth rates are well defined only for stationary but not nonstationary data (Yule, 1926).

An ideally defined and tested unconstrained VAR model can be understood as a limited description of the data covariances (Hendry and Mizon 1993; Juselius 2009) and thus represents reality as expected in the theoretical model. However, since VAR is highly parameterised, it is not very informative. If properly implemented, the ideal economic model of VAR would provide the accuracy of the data without abolishing the relevant information and would therefore provide a set of econometric laws that should explain the theoretical model as empirically valid. The CVAR model, mainly through disaggregated and harmonised data, provides a natural method of analysing economic data as short-run changes occur in long-run equilibrium. The long-run forces are divided into forces that shift balance (push forces that cause stochastic trends) and forces that correct deviations from equilibrium (pull forces that cause linking relationships). Explained in this way, CVAR has many ways of nesting a multivariate, path-dependent process of data emergence and a corresponding dynamic macroeconomic theory (Hoover et al., 2008). Reached the k-th order VAR is

$$x_t = \mu_0 + \Pi_1 x_{t+1} + \cdots + \Pi_k x_{t-k} + \varepsilon_t, t = 1, \dots T, \tag{2}$$

where ε_t is $NI_p(0, \Omega)$ and $x_0, \dots, x_{-k+1}$ are predetermined. Although, when the reviews of x_t are actively time-dependent, the conditional process $(x_t | X_{t-1}^0)$ is independent, and OLS estimates of $\{\Pi_1, \dots, \Pi_k, \mu_0, \Omega\}$ are Maximum Likelihood estimates. The example VAR is thus an econometric metamorphosis of (time-invariant) data covariances. Therefore, it can be used as a first general approximation to the real process of data formation (Hendry & Mizon, 1993).

4. RESULTS

In this dissertation, scientific, theoretical and applied research is performed. The results are recorded in four published scientific papers. The articles have been published in peer-reviewed and high-ranked impact international journals.

4.1 HIGHLIGHTS OF THE RESULTS

All published articles contain the dissertation's aims, objectives, hypotheses, ideas, and motivation. Therefore, the published material covers the topic and purpose of the dissertation. Hard copies of the specified articles are included at the end of this document.

The results emerge in an impressive scientific scenario that is overlooked in a list of essential tourism indicators and performance measures that need to be analysed in the tourism industry to predict overcoming events (low season, high season, demand, holidays, sustainability) and different shocks in the economy (crisis, prosperity, pandemic, inflation risks, natural disasters, war).

An example of such a list is consistent with measurements, OLS and innovative models. Therefore, a high value of the deterministic coefficient indicates non-normally distributed residuals. Moreover, the enormous value of the F-statistic indicates spurious time series results. Nevertheless, high lag order and autocorrelation show dependence on time, and the Jarque-Berra test indicates a non-normally distributed model.

In recent years, the economic overview of its macroeconomic sectors has become very important. This research has never been more crucial than it is today, whilst the most urgent challenge for Europe is to overcome the past and create a future for economic development under the banner of progress, thus embarking on the path of sustainable development. The main and two specific hypotheses have been tested during this path.

Specific outcomes of the published papers and achieved aims resulted in developing a cointegration analysis in time series and panels on macroeconomic variables for two neighbouring countries. Secondly, proof of results (normality) based on the cointegration analysis in a process modelling framework for Slovenia and Croatia is examined. Thirdly, two hypotheses for Slovenia and Croatia are tested. Finally, the theoretical approach to normalities in a model for predicting future economic frontiers in tourism based on contemporary theoretical modelling in the tourism industry is crisped.

The results are presented in Table 2, whereas main points of the published articles are presented hereafter.

Table 2. Results of hypotheses testing

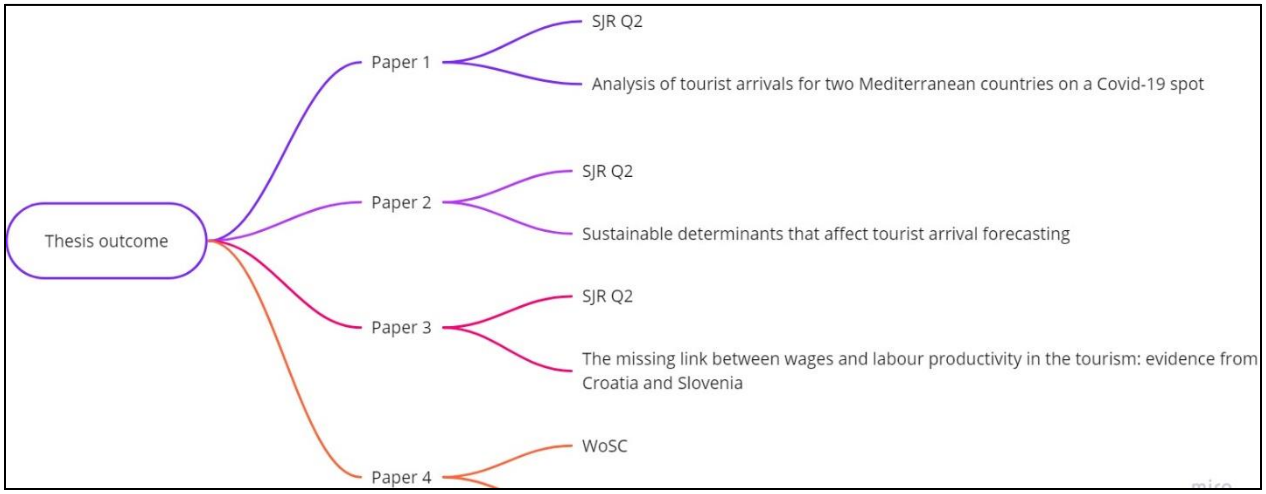
Hypotheses testing	The dissertation recognises several steps of econometric convergence between neighbouring countries in the Adriatic region. Several methodological and econometric procedures were applied during the research. Results are relevant and have immense future development in the field of cointegration. Nevertheless, reviewers confirm the distribution between neighbouring countries in the Adriatic region/destination.
Main H	An innovative approach to cointegration based on empirical evidence for Slovenia and Croatia provides unbiased, accurate and validated results for tourism development.
Results	The contents in all four published articles confirm a value-based analysis of time series for two countries, e.g., Slovenia and Croatia. Thus, the main hypothesis is confirmed, and the correction in time series was applied to two panels. Nevertheless, normalities for reliable econometric modelling were explored, leading to validated results.
H1	H1: The tourism industry in Slovenia has developed rapidly and is expected to grow even more in a positive and sustainable direction all year-round (not seasonal).
Results	The hypothesis is partially not rejected. The well-known slump in the tourism industry in 2020 has led to a decrease in tourist arrivals. Therefore, the hypothesis could not be accepted, but there is a prediction that a pause would not last long. The paper published in the Sustainability journal analyses that such an event will have medium-term effects. Moreover, the paper cites the prediction of such an event in 2020 with a 20% decrease. Finally, seasonality is no longer an issue.
H2	H2: The tourism industry in Croatia has a long tradition and has the opportunity to grow faster than in recent years, even decades. Volatility in the Croatian tourism industry is markedly significant. This status is an opportunity for positive and more productive growth. Therefore, the Croatian tourism industry offers an exciting research question focusing on a strategic time series approach.
Results	Affirmative. Croatia has experienced a decline in their tourism industry. The current analysis suggests greater participation of SMEs, higher productivity in the industry and attention to inflation in tourism prices. The recent sustainable effects could play a significant role in the exceptional growth of Croatian tourism in the upcoming years.

Source: Own source, 2022.

4.2 OVERVIEW OF THE ARTICLES

Four scientific articles have been published in renewed journals. The Scientific Journal Rankings (SJR) are shown in Figure 6.

Figure 6. Thesis outcome: published articles



Source: Own source, 2022.

All published papers deal with the main hypothesis and two hypotheses. The main contributions and results are presented in subsequent sections, whereas the whole text of the articles are attached.

4.2.1 Contribution of paper No. 1: Some considerations about tourist arrivals and Covid-19 pandemic – evidence from Slovenia and Croatia

The analyses set an impulse value for tourism on the Adriatic coast. Most importantly, the pandemic was a shock for Slovenian and Croatian tourism industries. The shock provides a robust test for empirical analysis in panels and is therefore complementary to primary research. Hypotheses 1 and 2 involve Slovenia and Croatia, which play essential roles in this spatial research through the cointegration VAR of tourist arrivals.

Moreover, relationships were found in published work for the analysed countries. Applied analysis is used to test tourism artefacts in the short-term on daily data for 2020. The econometric modelling and data plotting results confirm significant volatilities in the analysed time series and their peculiar response to the influence of Covid-19 on tourist arrivals. Therefore, innovative tourism policy and management should not expect pre-pandemic values and demand. Moreover, tourist expectations will change drastically in an epidemic decade, whilst several other determinants will influence tourist arrivals. The novelty of the study is twofold. First, the study provides an added value to empirical tourism demand determinants research. Secondly, the study can be considered a starting point for short, medium and long-term time series and panel econometric analysis of sudden shocks that influence tourism demand.

4.2.2 Contribution of published paper No. 2: Sustainable determinants that affect tourist arrival forecasting

This published article is on tourism modelling and the primacy of prediction. Moreover, econometrics enjoys popularity precisely because of the situations it can analyse with the methods used in this research. Furthermore, it is because of the results obtained in this way why it is crucial to present them to the professional community in scientific journals and the general public, using methods that predict the virus, among others, i.e. how the ecosystem influences tourism. What is interesting is the cause of this decline.

One factor is that the impact of the virus on tourism is only 16 to 18 per cent. Otherwise, the remaining factors are far more influential. In this model, CO_2 is generated, but rarely has it been considered as an influence on the arrival of tourists.

Several variables have been included in the analysis, such as tourist arrivals, CO_2 air pollution, rainfall in millimetres, clouds, hours of sun per day, viruses and bacteria and several other parameters mainly related to parts of the ecosystem. These calculations predict that the decline in tourist arrivals will be more significant than in previous years. These changes will occur regardless of the closure of national borders within the EU. The calculations were made based on past observations over more than 20 years and related methods.

The credibility and accuracy of future forecasts is an issue of substantial importance. It is hard to say now why CO_2 is affected so much. It is suspected that tourists from the North and West, who tend to be more environmentally friendly, drive less and pay more attention to environmental parameters, are more likely to travel to Slovenia and Croatia than to more environmentally-conscious countries.

Finally, the model predicts favourable growth in tourist arrivals from February 2022, whereas a drastic decline was expected for September/October 2021. According to our model, this decline started in the second half of July 2021, albeit mild but noticeable.

4.2.3 Contribution of published paper No. 3: The missing link between wages and labour productivity in the tourism: evidence from Croatia and Slovenia

The third paper presents the importance of reliable econometric models, starting from information for data in levels and then real data. This article is essential information for all researchers in tourism who work with secondary data, which means that it is challenging to use only data in levels without checking their relevance and stability. After that, the research uses different approaches; the most relevant being the data vector, which is finally presented in most published articles on this work. The lemma of this inclusion is:

$$ {}^{I(0)}_{\;T}[ARR\ EMPLOY\ W]_t^{i,j}\ {}^{ex}_{\;T}[CPI]_t^{i,j}, t = 1, \dots, 242, \tag{3} $$

where i and j are Slovenia and Croatia, respectively, ex is an exogenous variable, t time series and T length of time series, gross wage (W), and tourist arrivals (ARR), several employees (EMPLOY) in the tourism sub-sector.

A visual inspection is an essential part of scientific research. This procedure could provide relevant scientific conclusions, while normally distributed errors are most appropriate for macroeconomic research. The current study results regarding Slovenian and Croatian data show that productivity is unidirectional with real gross wages in both countries. The ECM predicts a productivity decline in tourism in Slovenia that is evident during the pandemic. The contribution of reliable econometric modelling is important. Overall, empirical findings and hypothesis tests are conducted for both countries. The data used ranges from December 1999 to January 2020, and the data are tested for cointegration, where the prediction is forced to occur. The variables identified are tourist arrivals, gross wages in tourism sub-sectors and employment using macro data.

4.2.4 Contribution of published paper No. 4: Modelling seasonal short-run effects in time-series tourism prices

Lastly, the contribution of this dissertation research will discuss and investigate normalities in tourism modelling. This article presents the main points developed during the research project that led to no violation of the results. The research utilized and tested several parametric tests that are widely used in the tourism industry, as well as methods for collecting secondary data.

The article presents the $I(1)$ and the $I(2)$ near prevalence of prices. The first article establishes the path of empirical time series methodology and completes the theory, while recognition of normalities is gained through the inevitable mention of whole numbers.

This paper presents a CVAR model to study the long-term evolution of tourism prices. The main theoretical contributions are first, an advanced integer for testing time series non-normality and second, the short-term cointegration margin of tourism prices. Additionally, it contributes to the study of creating spatially integrated nominal (observational) tourism prices into (real)prices in different economies and supports the most advanced technical analysis. Considering previous empirical studies, this study contributes to this area in several ways. The proposed spatially consolidated CVAR model is more straightforward and provides a more accurate representation of the dependence structure between the explanatory variables, e.g. tourism price indices. The proposed model is state-of-the-art, empirically well-defined and user-friendly. Our results also confirm the findings of other applied studies, that tourism prices are close to the second order of integration, and consumer price index is integrated at the first order.

5. CONCLUSION

The overall objective of the dissertation is to present a well-defined econometric model for predictions in the tourism economy. Collected time series data from the central data sources are essential for the analysis. The data and novelty of the research support the detection and identification of significant breaks in tourism through econometric data analysis. This is achieved through contemporary methodology using the CVAR model, panels and extensions.

5.1 DISCUSSION

The hypothesis tests presented in Table 2 and Figure 7 show that both hypotheses were partially not rejected, and the main hypothesis was confirmed. Overall, it could be concluded that tourism suffers predominantly from determinants other than seasonality.

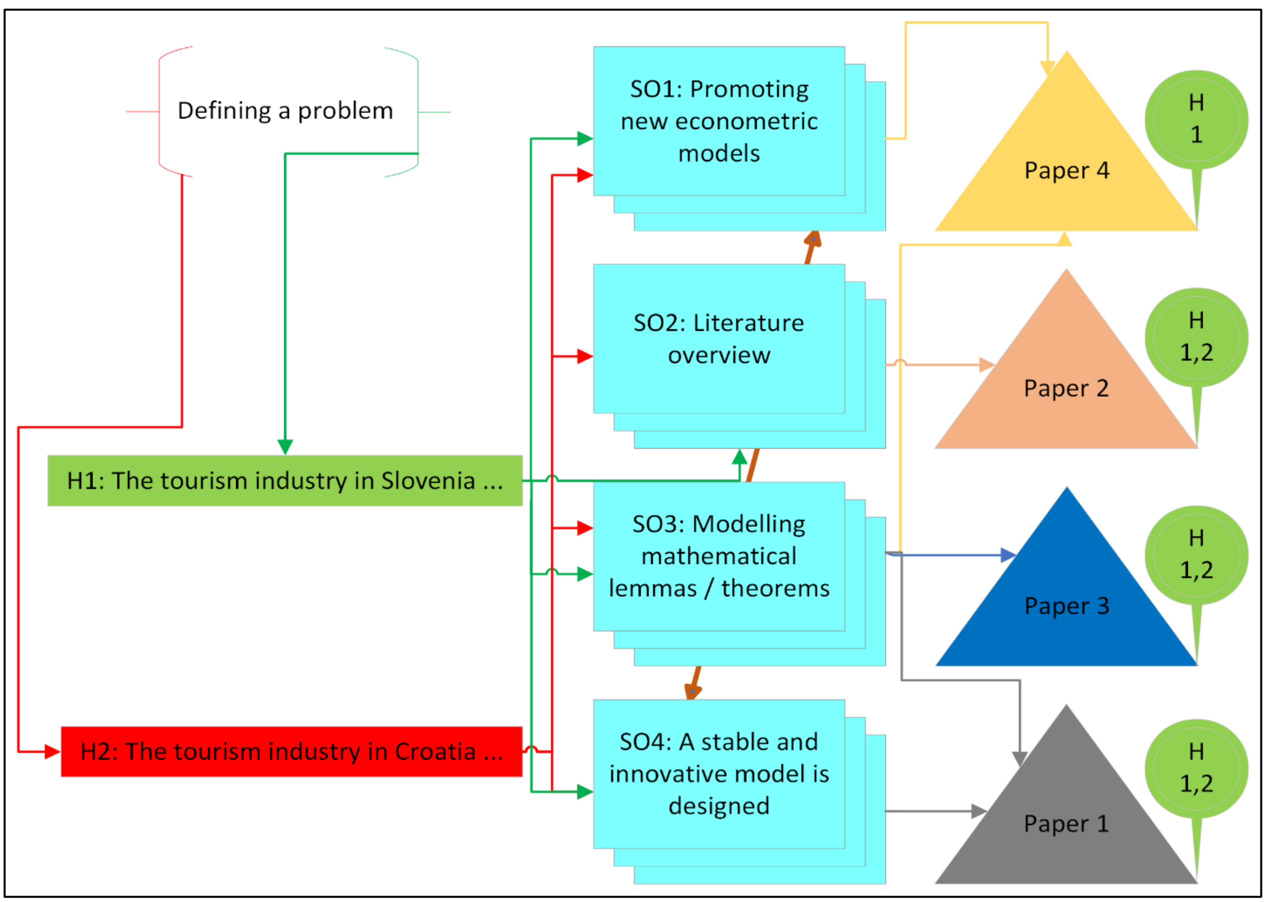
This problem was based on the validated modelling; most of the causes are bacteria, CO2 and other environmental aspects such as unsustainable transportation in both analysed countries. Apart from the applied analysis, econometric modelling using hypothesis testing leads to new steps in the normalities set in the specific objectives of the research in this dissertation. Moreover, hypothesis testing provides an overview of the next stage of empirical testing in tourism for a quantitative methodology that is more complex than regression analysis or bivariate autocorrelation and heteroscedasticity tests. The research objectives were achieved through the published papers and are as follows. SO1 was mainly conducted in the fourth published article, where a new econometric model was presented. While objective one was inserted primarily in the second and last published article.

SO2 is achieved with the second published article, in which an extensive literature review was conducted. Moreover, some additional work is carried out in the third article. Nevertheless, objective two has been developed with the help of the first and last published papers.

SO3 was achieved when the equations and lemmas were defined in the first two and the last published papers. While objective three was completed by the second article with cointegration modelling using sustainable determinants that affect tourism demands.

SO4 was solved whilst publishing the study on stability and normalities as ex-ante modelling. Therefore, the last and first published articles solve the problem given by objective four that tourism could always expect cycles.

Figure 7. Decision tree of the problem, hypotheses, SO`s and published papers



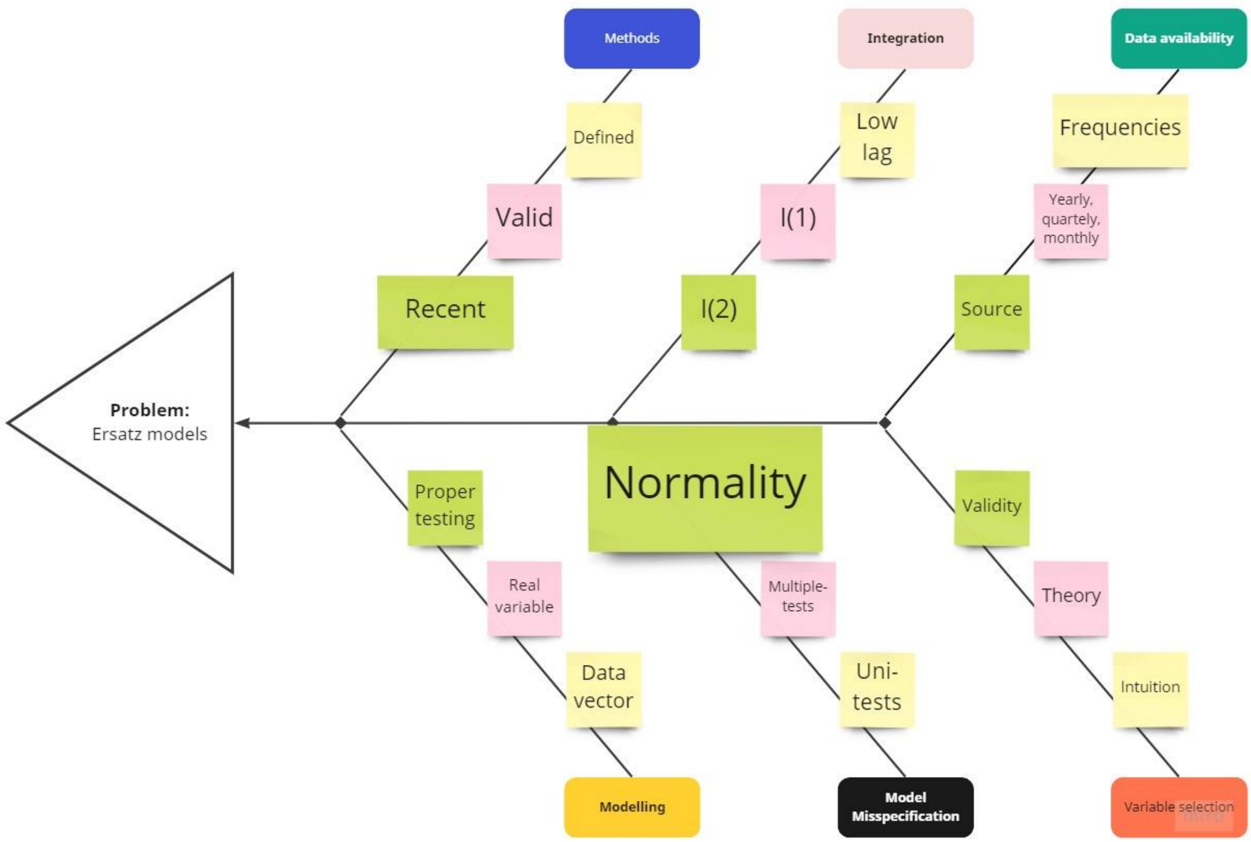
Source: Own source, 2022.

Finally, the following sections present the research with its main findings and results. All four papers are fundamental to econometric science and the tourism industry; more than ten reviewers also evaluated them. The research highlights are presented in Figure 6.

5.2 METHODOLOGICAL CONSIDERATIONS

A better introduction and development of quantitative analysis are necessary. The time series methods need reviewing, as is done in this research: cointegration approaches, process modelling and econometric models (second paper, p. 16). Secondly, variable detection is one step that requires more time and effort than researchers often anticipate. This is a crucial step that determines the research outcome, e.g., credible results and interpretations in a systematic, valid and forward-thinking manner such as ex-ante research. Finally, for reasonable discussion without spurious results and conclusions, some essential steps of the approach must be followed. These stages are shown in Figure 8, with some often omitted steps highlighted.

Figure 8. Fishbone diagram of spurious time series approach



Source: Own source, 2022.

A vital component of this research is residuals normality testing. This is not always considered in the reviewed empirical tourism studies, whereas in economics it is an integral part of analysis. The test used in this instance is the Jarque Berra test for normality of the residuals. Normality is challenging to determine and obtain for time series, thus researchers do not use it. However, it is essential for time series and being presented in published papers. In the articles, one could find consequences for estimated coefficients and statistical significance (i.e. bias of the results) if the normality assumption fails. Next, discussion sections in the attached papers explain which procedure should be used to test this.

Following the stationarity process, the attached papers use a different level of integration. The next important step is not to obtain the highest possible lag determined (such as Akaike Information Criteria (AIC) for example), but to get lag two as proposed by Julius (2009). It is essential to use the methodology presented in Table 1 to deal with misspecifications in the modelling.

Nevertheless, since it is challenging to get normality in time series, researchers usually move to panels, e.g. Erasatz models. If normality assumptions have not been met and we can not respecify the model to fulfil the property, it is recommended to use the panel. The current pandemic situation could underline the highlights, whilst only few researchers have predicted the status of recent years in the third decade of the 21st Century. One can conclude that all events are visible in the secondary data. Therefore, predictable shocks are applied to the definition of supply and demand. Due to income elasticity, tourists would expect to choose a destination. In addition, there are psychosocial triggers for the decisions related to CO_2, economic stability and sustainability factors.

5.3 COMPARISON WITH OTHER STUDIES

CVAR analysis for time series data seems to be the standard solution for describing data in a dynamic model (Hoover, 2020). Johansen (2012) and Juselius (2009) pointed out that some variables are at most $I(2)$ and should be correctly considered so that we do not miss important information. The published academic papers have addressed some relevant issues relating to the tourism industry.

Table 3. Review of the papers based on the methodology discussed

Author(s)	Geographical area and unit include research	Data frequency and period covered	Model / method	Sample size (T)
Peng et al., 2015	tourist demand, Worldwide	1961–2011	meta-regression analysis	195
Shah et al., 2022	Pakistan	1990–2018	nonlinear autoregressive distributed lag (ARDL) cointegration	20
Gounder, 2021	The African island nation of Mauritius	2003M11–2020M02	Granger causality	242
Gričar et al., 2021a	Slovenia, Montenegro	2010M01–2019M12	I(1) modelling cointegration Granger causality	120
Pérez-Rodríguez et al., 2021	EU countries	quarterly data from 1990 to 2018	fractionally cointegrated vector autoregressive	76

Source: Author compilation, 2022.

Under the keyword “cointegrated VAR tourism” in a Scopus database, 351 research papers were found. Slovenia represented only 12 of these, Croatia 51 and Slovenia and Croatia only seven documents (six of which were written by Gricar and only one by another author) (Peng et al., 2015). This observation indicates that the results of this doctoral thesis are progressive for the geographic region studied and beyond. Therefore, the considerations of CVAR for other authors in recent years (e.g. 2022) are presented in Table 3.

Taylor (1991) indicated that no article has addressed the problem of nonstationarity of variables, and also made a tentative statement that if the counter-momentum ($m - p - y$) and the inflation rate (Δp) are of unstable order, Cagan's model produces a companion between the actual inflation and the inverse velocity. In this case, the constant α is uniquely identified by the average of the cointegration property, regardless of the expectation formation in the prediction error, i.e., the divergence between the steady-state process of convolutional inflation. This assumption, i.e. $\Delta p \sim I(1)$ and hence $p \sim I(2)$, is reliable with the harmonised CVAR example for second-order data. Taylor's article thus draws attention to the Cagan model, which is re-estimated for episodes with multiple variables in the context of $I(2)$ cointegration (Juselius, 2022).

A short note from Table 3 depicts that most researchers dealt with Granger Causalities or meta-analysis where some more advanced methods and analyses have not been published in the past two years regarding CVAR. Therefore, recent research in this thesis shows necessary research for further development in tourism science worldwide.

5.4 SCIENTIFIC AND APPLIED DEVELOPMENT

A quantitative and systematic contribution to the dissertation is made, whilst there is need to scientifically elaborate on public perception and preliminary future developments in the tourism market. The dissertation aims to elaborate and define the proposed econometric methods. Moreover, shocks are analysed as variables (nominal, ordinal or dummy) within the econometric approach using applied econometric techniques and methods. These methods are well suited for normally distributed data with a cointegrated time series approach and panel cointegration. Before introducing cointegration, researchers had developed simple econometric techniques for regression analysis using OLS.

Nonetheless, visual inspection was used to combat the series idea of frequencies, plots and roots. The data vectors should be considered for an extended period. Furthermore, data collection is done through reputable sources, namely: national statistical offices, Eurostat, labour offices, the United Nations and other private or public agencies that provide primary layout data such as subsidies, self-employment, and other relevant macroeconomic data. The elaboration contributes to scientific knowledge of econometrics and forecasting (Clements, & Hendry, 1999), especially in Slovenia and Croatia. A dissertation leads to a more thorough understanding of econometrics. Four published papers provide some theoretical and empirical insights.

Moreover, experience in macro econometrics plays a vital role, while time series data of some variables become at least $\sim I(0)$. Therefore, shocks pass quickly. Alternatively, an economic downturn indicates the market's collapse. Studies add an infinite panel method for both countries. The shocks and dummies are bounced and implemented. Nevertheless, this work has to do with knowledge synergy, and its outcome is a set of citable impact studies that are achieved. Overall, objectives were achieved, and the hypotheses were validated and tested.

5.5 IMPLICATIONS FOR FURTHER RESEARCH

Trends in seasonal variations are rare in macroeconomics but can be found in tourism. Through its breaks the time series model can provide insightful results. One can also see that the model provides relevant results for forecasting. The trends of seasonal variations could be identified. The novelty of the research can be seen in tourism breaks demonstrated in the attached papers. Meaning reliable modelling provides ex-ante results. Therefore, this research could be a starting point for practical considerations on tourism determinants by providing information to tourist based businesses and their management on the events that boost or constrain the economy. Overall, such a scenario represents a significant advance in econometrics and tourism science.

The limitation of the study could be in the data vector. The period could be extended. Also, the variables could be highlighted, such as other determinants that should be included in the study. This issue should be further investigated to improve econometric modelling, prediction quality and efficiency. Given the empirical studies, further reports should contribute to this area in several ways. The proposed spatially consolidated CVAR model should be straightforward and provide a more extended period of the dependence structure between variables. Therefore, implications for further research lie in the robustness and degrees of freedom in the model for each specific data, meaning big data and artificial intelligence systems that lead to future recognition of obstacles and prediction.

Research delimitations lie primarily in the assumption that econometric time series models are sufficient for prediction. Future research should include the determinants mentioned in the articles: environmental factors, sustainability factors, economic factors, and psychosocial factors.

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7. LIST OF TABLES

8. LIST OF FIGURES

9. ATTACHMENTS

9.1 LIST OF ATTACHED SCIENTIFIC PAPERS AND CONTRIBUTION DOCTORAL STUDENT

Table 4. Scientific article No. 1

Paper 1.	Attachment 1
Authors	Gričar, S., Šugar, V., & Baldigara, T.
Title	Some considerations about tourist arrivals and the COVID-19 pandemic–evidence from Slovenia and Croatia
Publication date	7 April 2022
Journal Title	Economic Research – Ekonomska Istraživanja
ISSN/ISBN (e-ISSN)	ISSN 1331-677X, 18489664
Publisher	Taylor and Francis Ltd.
Year and volume	Ahead of Print
Pages (from-to)	/
Language	English
Journal Impact Factor	Q1/Q2 (JCR, SNIP, WoS)
Scientific Contribution	The development of a consistent econometric model for this research, together with the next ones, is a comprehensive and general scientific progress from an econometric point of view and empirical robustness.
Scientific Contribution of the Doctoral Student	Not to mention that the researcher enables econometric realisation that tourists do not recognise the boundaries. Rethinking government, tourism management and developing holidays is as important as mass, sophisticated and expensive tourism.
Applied Contribution	The purpose of the research and the published article is to define the idea of Adriatic destiny, which is of great importance to avoid obstacles in the seasonality and pandemics tested in hypotheses 1 and 2.

Table 5. Scientific article No. 2

Paper 2.	Attachment 2
Authors	Gričar, S., Baldigara, T., & Šugar, V.
Title	Sustainable determinants that affect tourist arrival forecasting
Publication date	27 August 2021
Journal Title	Sustainability
ISSN/ISBN (e-ISSN)	20711050
Publisher	Multidisciplinary Digital Publishing Institute
Year and volume	2021, 13(17)
Pages (from-to)	9659
Language	English
Journal Impact Factor	Q1/Q2 (JCR, SNIP, WoS)
Scientific Contribution	The modelling procedure was introduced based on the theory of seasonality and empirical settings for both countries analysed. This step was critical to the testing procedure. Normalities in the model were broadly consistent with theory, while homoscedasticity and autocorrelations presented difficulties.
Scientific Contribution of the Doctoral Student	In this paper, the main hypothesis was tested by developing an innovative model for cointegration analysis. Moreover, the innovative variables were introduced based on intuition and theory. Therefore, it is assumed that the best forecasting model has been developed, and the results are unbiased, accurate and validated for the tourism industry and beyond.
Applied Contribution	The results have a significant impact on society and policy. Therefore, the preliminary results were published in the dailies as we found that the tsunami prevails in the autumn of 2021, while tourist arrivals decline due to energy and food shortages, energy and food expenditures related to natural disasters and epidemics.

Table 6. Scientific article No. 3

Paper 3.	Attachment 3
Authors	Gričar, S., Šugar, V., & Bojnec, Š.
Title	The missing link between wages and labour productivity in tourism: evidence from Croatia and Slovenia
Publication date	4 September 2020
Journal Title	Economic Research – Ekonomska Istraživanja
ISSN/ISBN (e-ISSN)	ISSN 1331-677X, 18489664
Publisher	Taylor and Francis Ltd.
Year and volume	2021, 34
Pages (from-to)	732-753
Language	English
Journal Impact Factor	Q1/Q2 (JCR, SNIP, WoS)
Scientific Contribution	The results emerge in an enormous scientific scenario that is overlooked in a list of essential tourism indicators analysed to predict economic business cycles and shocks. The causalities between wages and labour of volatility in the tourism market in Croatia and Slovenia were analysed over 21 years. The normally distributed time series result confirms three cointegrated spatial relationships that are significant for the main hypothesis.
Scientific Contribution of the Doctoral Student	It was of enormous importance to understand the importance of econometrics in the crucial sector of tourism: employment. Therefore, the first analysis is based on productivity and the corresponding methodology defined by the first author.
Applied Contribution	The variables analysed in the study using secondary data from significant sources are gross wages in tourism sub-sectors, tourist arrivals and employment in the accommodation sector. Therefore, the empirical framework introduces the equation of labour productivity and real gross wages, with inflation as the denominator. Granger causality demonstrates two-directional relationships confirming H1 and H2 that higher labour productivity drives real gross wages. It is worth noting that labour productivity includes (increased) tourist arrivals as a numerator.

Table 7. Scientific article No. 4

Paper 4.	Attachment 4
Authors	Gričar, S., & Bojnec, Š.
Title	Modelling seasonal short-run effects in time-series tourism prices
Publication date	6 May 2022
Journal Title	Journal of Risk and Financial Management
ISSN/ISBN (e-ISSN)	ISSN 1911-8074
Publisher	Multidisciplinary Digital Publishing Institute
Year and volume	2022, 15(5)
Pages (from-to)	212
Language	English
Journal Impact Factor	Q2/Q4 (JCR, SNIP, WoS)
Scientific Contribution	Starting from the theoretical problem of $I(2)$ and $I(1)$ integration of prices and inflation, a new modelling procedure was developed that gives stability to the model. As many techniques as necessary were included in the research, but only the most important ones are presented in the published article.
Scientific Contribution of the Doctoral Student	This article is the most significant among those developed in the dissertation, as it theoretically advances the time series and adds tremendous value to econometric science.
Applied Contribution	Both countries were evaluated, and the main construction of the model was developed using Slovenian examples and the data of economic crises. In this research, the main hypothesis was tested, confirming the breakouts in the time series and expecting results in firms.

9.2 COPYRIGHTS OF THE ARTICLES ATTACHED

Work 1. **Some considerations about tourist arrivals and the COVID-19 pandemic–evidence from Slovenia and Croatia** is published as an Open Access Paper.

Work 2. **Sustainable determinants that affect tourist arrival forecasting** is published as Open Access Paper.

Work 3. **The missing link between wages and labour productivity in tourism: evidence from Croatia and Slovenia** is published as Open Access Paper.

Work 4. **Modelling seasonal short-run effects in time-series tourism prices** is published as Open Access Paper.

9.3 ATTACHMENT 1.

Some considerations about tourist arrivals and the COVID-19 pandemic – evidence from Slovenia and Croatia

Gričar, S., Šugar, V., & Baldigara, T. (2022)

Economic Research – Ekonomska Istraživanja. Ahead of Print.
https://doi.org/10.1080/1331677X.2022.2053781

Economic Research-Ekonomska Istraživanja

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Some considerations about tourist arrivals and the COVID-19 pandemic – evidence from Slovenia and Croatia

Sergej Gričar, Violeta Šugar & Tea Baldigara

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Some considerations about tourist arrivals and the COVID-19 pandemic – evidence from Slovenia and Croatia

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ABSTRACT

In late 2019 and early 2020, a sudden but not unexpected external shock occurred in the tourism industry. This study presents an explorative analysis of the literature review discussing a predicted exogenous shock in tourism caused by the appearance of viruses. Furthermore, the vector autoregressive (V.A.R.) models and panel econometrics is used to analyse and model the impact of the COVID-19 pandemics on tourist arrivals in Slovenia and Croatia. Applied analysis is used to test tourism artefacts in the short term on daily data for 2020. The results of econometric modelling and data plotting confirm significant volatilities in the analysed time-series and their peculiar response to the influence of the COVID-19 pandemic on tourist arrivals. Therefore, innovative tourism policy and management should not expect pre-pandemic values and demand; moreover, tourist expectations will change drastically in a calamitous decade, while several other determinants, not only COVID-19, will influence tourist arrivals. The study is novel in two respects. First, the study adds value to empirical research on the determinants of tourism demand. Moreover, the study can be considered a starting point for further short-, medium- and long-term econometric analyses of sudden shocks affecting tourism demand and government decisions affecting tourism supply.

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COVID-19 pandemic; Mediterranean tourist destinations; panel econometrics; time-series; tourist arrivals; vector autoregressive (V.A.R.) models

JEL CODES
C22; I18; Z32

Introduction

Prior to the twentieth century, there were several speculations about whether the year 2000 would even begin. The combination of numbers two and zero (2, 0) has not been reached until the second decade of the twenty-first century. The year 2020 began as a spellbinding story where people suffered from the viral Coronavirus disease (COVID-19), moreover, it is a decade wrought with a myriad of scourges

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(Gričar, Baldigara et al., 2021). Some authors (Gričar, 2019) succeeded to predict the proliferation of viral diseases and demonstrated a decline in tourist arrivals by 20%.

Few scientists use predictable statistical methods; therefore, the majority of research and discussions report well-known and defined problems. Nonetheless, history and recent discussions and research regarding positive COVID-19 cases suggested that the pandemic could last up to four years. Behind that, the economic threat is quite significant and of great impact on several economic aggregates. Rising inflation, which could impede people's life, is scarcer but evident shortly. Behind rising costs of living, including food followed by higher interest rates, manifests new threats (Yang et al., 2021). Additionally, overwhelmed stock markets are hazardous (Memon et al., 2021; Shaikh, 2021; Umar et al., 2021). The rising effects of inflation are not supported by the standard of living and a pandemic (Khalid et al., 2021).

Overall, contrary to majority wishes, it seems that, according to Sridhar (2020), the COVID-19 pandemic will not be dispelled before 2023. In the meantime, the socio-economic and physical status of residents and non-residents declines, and these adverse afflictions go beyond the health outbreak alone. In November 2019, pioneering research attempted to model and predict tourist arrivals in a pandemic situation. The study was developed by Gričar (2019) and is considered the starting point for the present study, while *ex post* and *ex ante* research is of utmost importance. The main objective of the present study is to extend the primary *ex ante* research that recognised the decline in tourist arrivals before the outbreak of the COVID-19 pandemic. The researcher predicts the pandemic using regression analysis. The regression analysis has been further used by Kostynets et al. (2021). Thus, the objective motivation of this research is to extend the ordinary least squares (O.L.S.) methodology to time series and panel regression steps (Baldigara & Mamula, 2015; Karadzic & Pejovic, 2020). The use of breaks in time series in vector autoregressive (V.A.R.) model and cointegrated V.A.R. (C.V.A.R.) model are much better diagnostic modelling than other multivariate analyses (Juselius, 2009).

The following section presents a historical review of the econometric mirror with two questions related to pandemics and econometrics followed by the literature review. In the central part of the article, the used methodology, data and results of the econometric approach are laid out. Finally, the discussion and conclusion bring a final touch to the research.

Pandemics and econometrics – a historical overview

In economics and econometrics, prediction is based on the proposition that past events predict future events. For example, the main threat in the Middle Ages was the plague, which peaked in the fourteenth and fifteenth centuries. It is worth noting that plagues occurred years earlier, around the tenth century. More recently, there were several earthquakes and volcanic eruptions, e.g., Fagradalsfjall and La Palma volcanoes. Considering that time series econometrics predicts the future from past events could impact the tourism economy as pandemics begin, earthquakes occur, and volcanoes erupt. Firstly, are we approaching the peak of a pandemic and the lowest part of tourist arrivals?

The importance of tourism in national economies, employment, gross domestic product (GDP), small and medium enterprises, different organisations, institutions and stakeholders has been recognised by several scholars (Brida et al., 2016; Južnik Rotar et al., 2019). Vinogradov et al. (2020) report Airbnb-induced tourism growth. Provenzano and Baggio (2020) propose simple methodological steps in tourism and hospitality industry forecasting.

Secondly, are we facing the new normal as a metaphor? (Ateljevic, 2020; Roven, 2020). The critical historical events can be a war bell for econometricians to use trending and cycles in econometric modelling without overlooking obstacles, minimum and maximum. History shows us the comparison of past events and future well-being and could be represented econometrically, as proposed by Gričar, Šugar et al. (2021) $Y_{t-1}|Y_0|Y_{t+1}$.

The purpose of this research is to present an approach to the analysis of waves in tourist arrivals for Croatia and Slovenia to confirm the misunderstanding of rising events in tourism by multiple stakeholders that do not include reactions to a sudden exogenous event. Researchers have noted an increase in tourist arrivals, albeit domestic or international, for several decades with occasional interruptions. For several years, the World Tourism Organisation (UNWTO, 2020a), as the umbrella organisation for tourism development, published its bulletin, which was used countless times by scholars who did not think that every period of maximum has a peak and therefore it is time to turn to a minimum. There were no downward trends in the UNWTO (2020b) bulletin, which is econometrically a misleading story. In addition to the recent paper on the impact of the crisis by Duan et al. (2022), these effects motivated our research on the well-being of volatility in tourist arrivals in time series data. It is of great importance to get the information from the data, the plotted data, while Juselius (2009, 2021) stated, a decade ago, that the data should be let speak freely. Based on the previous statements, and objectives two hypotheses were tested. The main thesis is: The tourism industry in Slovenia and Croatia has developed rapidly, and it is predicted its growth even more in a positive direction and year-round (not seasonal). This is an opportunity for positive and more productive growth? Therefore, the Slovenian and Croatian tourism industry offers an exciting research question focusing on a strategic approach using time series:

H1: In the short term, tourist arrivals in Slovenia declines due to the COVID-19 pandemic.

H2: In the short term, tourist arrivals in Croatia declines due to the COVID-19 pandemic.

Literature review

A detailed literature desk-research has evidenced that fewer authors attempted to forecast the rise of the pandemic COVID-19 pandemic *ex ante*. On the other hand, a pretty significant number of discussions and research are dealing with *ex post* COVID-19 pandemic analysing and modelling. Table 1 outlines the research dealing with the COVID-19 pandemic modelling and forecasting; for example, Kaushal and Srivastava (2021) propose a better preparedness for outbreaks in tourism.

Table 1. Coronavirus (COVID-19) literature review desk-research.

Author(s)	Pinpoint	Highlights of the research	Ruling
(Alsayed et al., 2020)	Prediction	The mathematical modelling on a genetic algorithm Predicting COVID-19 peaks	*Ex post*
(Gallego et al., 2020)	Unpredictable	Unpredictable future events The territory of the COVID-19	*Ex post*
(Gričar, 2019)	Forecast	Regression analysis Tourist health and treatment	*Ex ante*
(Hugo, 2021)	Prognosis	Innovation of tourism	*Ex post*
(Kostynets et al., 2020)	Shocks	Pandemic and other shocks that consequences tourism demand	*Ex post, & ex ante*
(Kostynets et al., 2021)	Pent-up demand	Influencing demand regarding COVID-19 pandemic	*Ex post*
(Wang et al., 2021)	Prediction, Forecast	RegARMA modelling Railway passengers and gross domestic product	*Ex post*
(Wong et al., 2007)	Forecasting	Modelling tourism demand ARIMA	*Ex post*
(Yang et al., 2018)	Predictive	Several methods plus ARIMA Time series data	*Ex post*
(Yue et al., 2020b)	Prediction	ARIMA Trending breaks and shocks	*Ex post*
(Yue et al., 2020a)	Prediction	New predictable research Modelling process in tourism	*Ex post*
(Zhang, Song et al., 2021)	Prediction	Post COVID-19 effects Mixed study methods	*Ex post*

Source: Authors compilation, 2021.

Fotiadis et al. (2021) and UNWTO (2020a) are predicting what was already apparent and predicted by Gričar (2019) and Gričar, Baldigara et al. (2021, p. 13), a decline in tourist arrivals. Tourism sharing is an essential generator of economic recognition, according to Sainaghi et al. (2020). Nevertheless, a comprehensive empirical methodology was used, and the prediction is 10 percentage points higher than that of Gričar (2019). Moreover, Sharma et al. (2021) revived the idea of new waves in tourism in post-pandemic tourism. The question, which has not been asked in the research is, when will the recovery start? Škare et al. (2021) predict a more prolonged recovery in tourism than the average recovery from an average crisis is. Additionally, Hu et al. (2021) addressed the evaluations of tourists' experiences during the pandemic collected via the World Wide Web. They predicted a differentiation in tourists' behaviour.

Several countries are studied in the literature based on the COVID-19 pandemic and tourism (Esquivias et al., 2021; González-Torres et al., 2021; Hu et al., 2021; Jeon & Yang, 2021; Sobaih et al., 2021). For Slovenia and Croatia, on the other hand, there are fewer published articles (Gričar, 2019; Perić et al., 2021; Williams, 2021), so this is one of the first attempts to shed new light on the importance of these two Mediterranean countries among tourism actors. Perić et al. (2021) recognised Slovenia and Croatia as small countries with fewer cases in the first wave of the pandemic. Williams (2021) added a study of entrepreneurial and labour instability during the pandemic.

Additionally, some other researchers recognised other values for waves in tourism. Martini and Buda (2020) offer a deeper layer in death and disaster places. Senbeto and Hon (2020), and Ateljevic (2020) focused on shocks causing peak and through waves, while Çanakçı and Birdir (2020) and Seidell (1995) on food neophobia epidemic. Ferrari et al. (2018) find the change in tourists' income essential for tourism spending and food demand. There were some previous attempts to pandemic effects which were nicely summarised by Duan et al. (2022), leisure vs health nexus discussed by Peel et al. (2021) and outdoor safety perceived by Zanon et al. (2019).

Outline of ex ante *research*

The time we are living is sufficient and abundant. Nevertheless, it is of primary interest to consider strategic questions and science. Scientific research should be based on data and a quantitative approach in providing guidelines for overcoming external shocks that negatively afflict tourism determinants. Nowadays, the research should be focused on the COVID-19 pandemic situation and tourist arrivals. Many European countries suffer from the pandemic (Dye et al., 2020).

Additionally, the COVID-19 pandemic has not yet ended. Based on the normally distributed data, some prognoses show that the virus is still present (*The Covid-19 Tracker Slovenia*, 2021). Researchers recognised, from tourist arrivals and microbial variables in vector correction modelling (Gričar, Baldigara et al., 2021), that COVID-19 began in April/May 2019, not December 2019, as indicated by Fong et al. (2021). The wave's peak will be reached after two to two and a half years, starting in April/May 2019, and the trough will be reached in the next two years, ending in spring 2023, for four years (Sridhar, 2020).

Secondly, tourism fills moments in our life. Therefore, people living in European Union (E.U.) have a physical need to plan their vacation on the Mediterranean coasts. For E.U. residents, it is customary to find ways to escape from everyday life. This solution is a must that should be offered by policymakers this and next summer. Overall, the first thing that comes to our minds is science based on the COVID-19 epidemic. The second thing that meets their needs is summer vacation. Prognostic models are abundant. In the conclusion of the section, the discussion of a pre-epidemic prognosis by Gričar (2019) on a medium-term and the data of NIJZ (2020) is applied. The research was based on the idea of Provenzano and Baggio (2020) to keep the quantitative analysis credible and straightforward based on 108 monthly time series data, with the twelve most common microbes (viruses and bacterias) included. After including twelve regressors in the O.L.S. model, the reference model showed the association of viral infections on tourist arrivals. The main threats to tourist arrivals were detected *viral infections* and disease spread. The empirical evidence shows: each such case was associated with a reduction in tourist arrivals of 63.25 persons per month. This result has some important implications for tourism and health policy. For example, looking at the linear regression function, between March 4 and March 28, 2020, related only to the COVID-19 epidemic, this would result in a decrease of 46,615 tourist arrivals (737 *patients* · 63.25) per month on average, out of 314,772 monthly tourist arrivals in Slovenia, or by 17.77%. The result is consistent with the finding of Gössling et al. (2021). They predicted a decrease in international tourist arrivals between 20% and 30%. In addition, the table of Gričar (2019) is translated to be

Table 2. Values (coefficients) of the variables studied, dependent variable number of tourist arrivals, January 2008–December 2016. $N = 108$.

Regressor, constant	Coefficient*	t-statistics	*p* value	Incidences,
Constant	97,281	2.48	**0.01**	/
Cholera	−56,046	−0.84	0.40	1
Salmonella	292	1.33	0.19	4515
Dysentery	1795	0.60	0.55	242
E.coli	3619	3.46	**0.00**	1487
Campylobacter	1760	8.76	**0.00**	9664
Enterococcus and Staphylokokkus	320	0.74	0.46	7155
Botulism	3163	0.12	0.91	4
Clostridium and B. cereus	−89	−0.39	0.70	1360
Viruses	−34	−2.31	**0.02**	175,569
Listeria	10,628	1.62	0.11	94
Sepsis	−225	−0.47	0.64	8132
Hepatitis A	1280	0.23	0.82	113
Statistical values of the model				
F statistics	20.68			
D-W statistics	1.73			
Deterministic coefficient	0.69			

Source: Gričar (2019).

presented in this article as part of the literature review (Table 2), where statistically significant *p* values are in bold numbers.

The value of the adjusted coefficient of the deterministic coefficient is 0.69, which means that the regression model explains 69% of the variability in tourist arrivals in Slovenia with reported microbial infections.

Secondly, the results suggest that tourist arrivals in Slovenia were not susceptible to the identified *bacterial* infections. Despite the identified presence of three statistically significant bacterial infections in the country, tourist arrivals increased, influencing the post-pandemic tourist boom. Moreover, the results based on the first differences confirm the results of O.L.S. For the first differences, the adjusted deterministic coefficient is 15%, the statistic of Durbin-Watson is 1.9, and the statistical significance of the regression coefficients is less than 1% for the log variables Campylobacter and viruses, with a constant of 0.01.

However, the short-term shock may be nonlinear, and the decline could be more severe, as was the case in early April 2020 in a broader European and Mediterranean region (Marti & Puertas, 2021), as well as in many other parts of the world (Zhang, Gozgor et al., 2021). Shocks occur at very short intervals and tend to impact in the short to medium term and then worsen in the long term. Some other models have predicted or showed the impact in a short to medium-term volatility time series for tourism (Batool et al., 2021; Gričar, 2019).

Therefore, there is a need for greater collaboration and networking between closely linked sectors with the tourism and hospitality industry and urgent organised health measures to reduce, control and manage the spread of infections among tourists (Xue et al., 2021). The globalisation of economies and tourism economies have brought rapid economic growth and improvements in the well-being of the population, which should be assured with national, regional and global efforts to control worldwide shocks in global tourism and tourist arrivals, which are faced by many national tourism economies and finances (Gričar, Šugar et al., 2021; Liao et al., 2021; Li & Xu, 2021).

Data and methodology

Every year all the Mediterranean countries suffer from seasonality (Secondi et al., 2011). The analysis is based on seasonality as a crucial tourism demand feature of the two Mediterranean countries Slovenia and Croatia. Two hypotheses are considered, involving two variables tourist arrivals and positive COVID-19 cases. The secondary data used for variables were obtained from the two sources: the variable COVID-19 confirmed positive cases, obtained from the European Centre for Disease Prevention and Control (E.C.D.C.) website (European Centre for Disease Prevention and Control (ECDC), 2021). Data for the number of tourist arrivals (CBS, 2021; SORS, 2021) were isolated from the Statistical Offices of Slovenia and Croatia.

Data vector is from March 5 to December 14, 2020, based on daily observations for positive COVID-19 cases (C.O.V.) and average daily values on monthly tourist arrivals data (A.R.R.). Therefore, the data vector is as follows:

$$ {}^{191}_{705}[COV\ \ ARR]_t^T, \tag{1} $$

where 191 is a numeric abbreviation of International Naming Convention for Croatia and 705 is an abbreviation for Slovenia (ISO, 2021).

The research relies on several econometric methods. First, in empirical modelling, regression analysis based on O.L.S. is presented in Table 2. It contains many lemmas and ideas for distinguishing multiple variables regarding the relationships between the regressed variable and one or more regressors. Nonetheless, this set of statistical procedures points out the importance of how the primary value of a dependent variable changes when one of the independent variables change while the other explanatory variables do not. Regression analysis:

$$ y_t = \alpha + \beta_i \cdot x_{t,n} + \varepsilon_{hs}, \tag{2} $$

is performed for both hypotheses, where y_t are tourist arrivals as the dependent variable, α is a constant, β_i is a regression coefficient that shows the direction and dimension of the relationship between the dependent variable and the independent $x_{t,n}$ variable, where n shows the number of regressors, ε_{hs} are model errors based on the distribution of residues over the difference of the time series between h and s. The work of Gričar (2019) presents a dependent variable as tourist arrivals, while his independent variables are the 12 most common microbes in Slovenia.

Second, the residuals in a time series have a unit root. It states that the residuals are non-stationary. The null hypothesis is usually determined as having a unit root, and the alternative hypothesis is stationarity, trend stationarity or has an explosive root depending on the test used. The unit root test produces a more accurate approach to the tourism industry on the data obtained. An analysis is performed for hypotheses H1 and H2.

Third, in the diagnostic checking, the autocorrelation and the normality should be jointly considered. Note, however, that it depends on the space (geographically) in which the autocorrelation assumption operates, the framework vicariously can be used, and perhaps an O.L.S.-like transformation, e.g., time series, can be performed.

Time series are versions of the model obtained from several sources and the V.A.R. model:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \alpha_{11} \\ \alpha_{21} & \beta_{21} \end{pmatrix}_{\Pi} \cdot \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix}, \tag{3}$$

is implemented. The u are i.i.d. residuals, β are the regressed coefficients, y are the regressors, y_{t-1} are the integrated parameters, and Π is the defined matrix with the coefficients and the constant α. The additional test for the panel regression to test the hypotheses,

$$y_{it} = \alpha + \beta_i \cdot x_{t,n} + \mu_i + v_{ij}, \tag{4}$$

is achieved (Južnik Rotar et al., 2019). The balanced panel has, for each cross-sectional unit v_{ij} the same number of time series observations (capturing everything that remains unexplained about y_{it}) or a detour. The number of observations is 286. The remaining disturbance is μ_i, which is as high as shocks are delivered.

Finally, in descriptive statistics, a summary of statistical parameters is added to summarise observations and convey most of the information as simply as possible. Summary statistics provide a basic overview of the sample and the conclusions reached. Such summaries can be quantitative, i.e., descriptive statistics, or pictorial, i.e., easy-to-understand drawings in graphs, which is exclusively used in this study.

Results

Descriptive statistics

According to E.C.D.C. data (ECDC, 2021), the first COVID-19 case was isolated in Croatia on February 26, 2020, and Slovenia on March 5, 2020. The missing values in the series for Croatia were on days 5, 9 and 10 March 2020 and for Slovenia on March 9, 2020. Therefore, the analysis of COVID-19 cases related to tourist arrivals from March 5, 2020, to the last available source in ECDC (2021), i.e., December 14, 2020, is treated daily. Missing values and zero values are replaced by 1 to obtain a non-zero denominator and avoid miss indexation. The daily values for tourist arrivals are the average monthly values. Since the series are still short, the use of daily values is necessary.

Overall, the part of the descriptive statistics is calculated on the data vector from March 5 to December 14, 2020. Data for Slovenia and Croatia are isolated and presented in the following subsections. It is worth noting that both variables are converted to: (1) the chain base index $I_{t+1} = y_0/y_{t-1} \cdot 100$; and (2) to the fixed index $X_t = I_t \cdot X_{t-1}/100$, where March 5, 2020 = 100.

Croatia

Descriptive statistics for Croatia confirm the peak month for tourist arrivals, i.e., August 2020. On the other hand, the peak period of positive COVID-19 cases has been isolated for the end of 2020. Nevertheless, the rising effect in the pandemic for Croatia is present without seeing a low point in the epidemic wave. Look at a graph showing a wave because it seems like a diagram of an ocean wave, with the highest point (peak) at the top and the lowest point (trough) before the next wave. Econometrically, this is explained as an i.i.d. distribution of data.

With the onset of winter and colder temperatures in the two countries studied, we have seen a surge in infections, an epidemic tsunami. On the other hand, summer offers an imperative of tourist demand.

Slovenia

The descriptive statistic for Slovenia is plotted in Figure 2, from which it is apparent that a higher incidence of COVID-19 cases in Slovenia leads to a lower number of tourist arrivals. According to the normal distribution theory, we can expect a decrease in COVID-19 cases for the next two years (e.g., 2022/2023) and the level of tourist arrivals to the level before the pandemic in the next two to three years (e.g., 2022/2024).

Plotting the summary statistics brings an overview of the data transportation and distribution. The analysis of Figures 1 and 2 confirms high volatility in tourism demand. First, for Croatia, it is evident from Figure 1 that the volatility is high and concentrated in the high season; therefore, the main hypothesis is confirmed in a partial agreement that the tourism industry is high and immense. On the other hand, Figure 2 represents that Slovenia had slower growth in tourism demand.

Overall, it can be concluded that both analysed countries are dealing with a more significant number of tourists even in case of a pandemic, be it domestic or international tourist arrivals. In conclusion, Croatia has higher volatility in COVID-19 cases than Slovenia, and consequently, this is reflected in tourist arrivals, which is apparent when overlaying the left parts of Figures 1 and 2. Therefore, the main hypothesis of using time series in the scientific approach is confirmed.

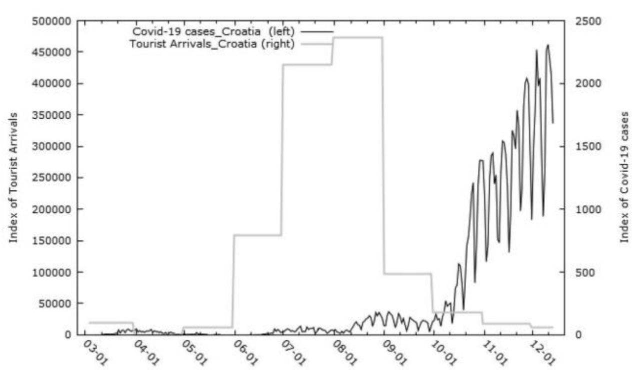

Figure 1. Comparison of COVID-19 cases and tourist arrivals in Croatia for 2020, daily data, fixed index March 5, 2020 = 100.
Source: Author's calculations and rectifications from ECDC (2021) and CBS (2021).

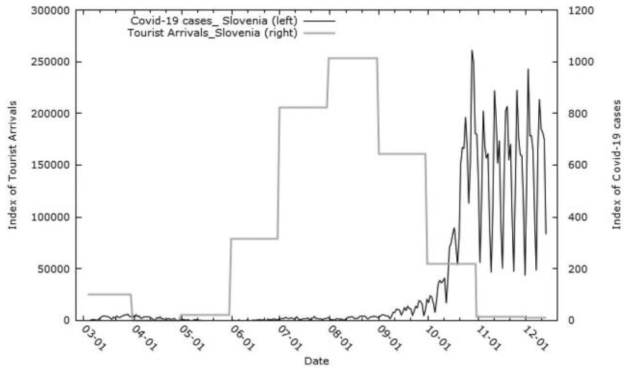

Figure 2. Comparison of COVID-19 cases and tourist arrivals in Slovenia for 2020, daily data, fixed index March 5, 2020 = 100.
Source: Author's calculations and rectifications from ECDC (2021) and SORS (2021).

Regression analysis and V.A.R

It is of central econometric and modelling importance to get an overview of the distribution of the variables. Therefore, the second consideration for the empirical treatment of the study is the regression analysis based on the O.L.S. technique. The result of the regression analysis based on the theoretical consideration of the O.L.S. Equation (2) for Croatia:

$$ARR_{191t} = 810.21 + (-0.002 \cdot \underset{(-5,19)^{\{0.00\}}}{COV_{191\,t}}) + \varepsilon_{ij}, \quad t = 1, \dots T; \; T = 286 \tag{4}$$

claims to be a highly statistically significant result with an F-test value of 26.95. The t statistic value is in a parenthesis, and the p-value is in a brace. On the other hand, the Durbin-Watson statistic (D-W) is 0.04, indicating a high positive autocorrelation between the variables and, as such, it is not very remarkable to be tested as a regression coefficient it is known in time series methodology. The deterministic coefficient is 0.09, indicating that tourist arrivals can only be interpreted in 9% of the variance of COVID-19 positive cases. The adjusted deterministic coefficient is 0.08, eliminating the influence of some explanatory variables.

The result of the regression analysis for Slovenia is:

$$ARR_{705t} = 405.34 + (-0.002 \cdot \underset{(-6.32)^{\{0.00\}}}{COV_{705\,t}}) + \varepsilon_{ij}, \quad t = 1, \dots T; \; T = 286 \tag{5}$$

with t statistic value in parenthesis and p-value in a brace. The F-test reliability at 39.94 of the regression equation shows its high statistical significance. The deterministic coefficient and the adjusted one at 0.12 show that the included explanatory variable explains 12% of the dependent variable. Despite a relatively small proportion, there is a sign of some influences; therefore, further investigation is needed.

Table 3. Misspecification test, daily data, fixed index, March 5, 2020 = 100.

		$I(0)$		$I(1)$, ln	
Test Variable	Standard deviation	ADF (χ^2)	Jarque – Bera normality test	ADF (χ^2)	Jarque – Bera normality test
Tourist arrivals Croatia	869.52	−1.41	65.89***	−16.79***	67520.80***
Tourist arrivals Slovenia	362.06	−1.11	37.81***	−16.79***	194049.00***
Positive COVID-19 cases Croatia	112760	1.89	287.37***	−3.23**	41.73***
Positive COVID-19 cases Slovenia	62793	−0.09	229.74***	−3.59**	85.71***

Source: The author's compilation based on data is obtained from CBS (2021), ECDC (2021), SORS (2021).
Note: A.D.F. – Augmented Dickey-Fuller test, ***, ** – 1%, 5% significance level, $I(0)$ – levels, $I(1)$ – first difference, ln – logarithm.

The not so surprising results for both analysed countries tend to confirm the influence of the COVID-19 pandemic on tourist arrivals with a high significance level of t statistics, a low regression coefficient accompanied with a low D-W statistic. On the other hand, the validity of the time series, loosely speaking, is again confronted with the subjective thinking of managers and politicians, which is why the importance of the following three steps in the analysis procedure enters into the econometric decision.

First, related to the results of the regression analyses, the misspecification tests are calculated. From Table 3, it is evident that the usual procedure of treating the time series for autocorrelation and normality during the COVID-19 pandemic is econometrically incorrect. The results show that autocorrelation is not present based on Augmented Dickey-Fuller tests (A.D.F.), but there are still non-normalities in the data. This nonnormality is the reason for the further modelling procedure. The second model is V.A.R., and the third is panel regression. Overall, the results of the misspecification test confirm that the volatility in tourist arrivals and positive COVID-19 cases has a giant swing in both directions, followed by a high standard deviation.

The data distributed in levels are transformed in logarithm, and thus the data vector is obtained:

$$\Delta\left({}^{191}_{705}[cov\ \ arr]_t^T\right)^{I=1}, \tag{6}$$

where Δ denotes transformation of the data vector, lower case letters logarithm variables and $I = 1$ denotes the treatment of variables integrated in the first order of integration.

The V.A.R. 'cays' that positive COVID-19 cases have no significant impact on tourist arrivals, i.e., the pandemic itself correlates with the procurement of other influences, e.g., political restrictions. Therefore, it can be concluded that the only salvation for tourism is policy, not the pandemic, while it has no direct influence, as shown by the two lagged dimension V.A.R.(2) for Croatia:

$$\begin{pmatrix} arr_{191t} \\ cov_{191t} \end{pmatrix} = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} -0.66_{(-11.79)} & 0.00_{(0.09)} \\ -0.06_{(-0.75)} & -0.85_{(-15.53)} \end{pmatrix}_{\Pi} \cdot \begin{pmatrix} arr_{191t-1} \\ cov_{191t-1} \end{pmatrix}$$

$$+\begin{pmatrix} -0.33_{(-5.91)} & 0.02_{(0.51)} \\ -0.09_{(-1.08)} & -0.41_{(-7.50)} \end{pmatrix}_{\Pi} \cdot \begin{pmatrix} y_{1t-2} \\ y_{2t-2} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix}, \tag{7}$$

as its procurement from Equation 3, and t statistic values in parenthesis. Lastly, the dimensions are tested in V.A.R.(2) framework for Slovenia:

$$\begin{pmatrix} arr_{750t} \\ cov_{750t} \end{pmatrix} = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} -0.67_{(-11.79)} & 0.00_{(0.09)} \\ -0.06_{(-0.75)} & -0.85_{(-15.53)} \end{pmatrix}_{\Pi} \cdot \begin{pmatrix} arr_{191t-1} \\ cov_{191t-1} \end{pmatrix}$$

$$+ \begin{pmatrix} -0.33_{(-5.91)} & 0.02_{(0.51)} \\ -0.09_{(-1.08)} & -0.41_{(-7.50)} \end{pmatrix}_{\Pi} \cdot \begin{pmatrix} y_{1t-2} \\ y_{2t-2} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix}, \tag{8}$$

where the results confront the panel regression as another method of investigation.

Panel regression

In a short period, the treatment in the usual time series approach as given above is not highly accurate, while the degrees of freedom could be zero. Since the volatility in the time series is enormous, an additional investigation is necessary, so a panel regression is performed. There are two individual units (Slovenia and Croatia) and two time series tourist arrivals, and positive COVID-19 cases in 2020 spanned in a cross-section. Based on Equation 4, with the assumption that disturbance term $u_{it} = \mu_i + v_{ij}$ is constant over time (Brooks, 2015, p. 529), the results in first differences for Croatia are:

$$arr_{191t} = 0.00_{(0.99)} + 0.01_{191} \cdot \underset{(0.57)}{cov_{t,1}} + arr_{705} \cdot \underset{(0.00)}{0.30_{t,1}}$$

$$+0.00_{705} \cdot \underset{(0.72)}{cov_{t,1}} + \mu_{\mathrm{i}} + v_{ij}, \tag{9}$$

with a D-W statistics 2.02. Additionally, the results for Slovenia are:

$$arr_{705t} = 0.00_{(0.96)} + (-0.02_{705} \cdot \underset{(0.65)}{cov_{t,\ 1}}) + arr_{191} \cdot \underset{(0.00)}{2.77_{t,\ 1}}$$

$$+(-0.03_{191} \cdot \underset{(0.62)}{cov_{t,1}}) + \mu_i + v_{ij}, \tag{10}$$

where p values are in parenthesis and D-W statistics for Slovenia is 2.01. For each country studied, the dependent variable is tourist arrivals. The independent variables are positive COVID-19 cases for individual $i = 191$ *or* 705 at time t. Tourist arrivals as a spatial cross-section is a second independent variable.

The panel regression confronts two neighbouring countries in a spatial dimension of tourist arrivals even through the pandemic. The influence on Slovenian tourism has Croatian tourism with a statistically significant coefficient of 2.77 (Equation 9). On the other hand, Slovenian tourism has a more minor but significant influence on Croatian tourism with a panel regression coefficient of 0.30 (Equation 9).

Moreover, the spatial dimension shows that the results on Slovenian tourism do not have a compelling impact on the domestic or imported COVID-19 pandemic. On Croatian tourist arrivals, a COVID-19 pandemic also has no significant direct impact. Government and policy decisions could explain the results; econometrically, the data speak: COVID-19 alone has no direct impact on tourist arrivals in the two countries studied. Moreover, it could be concluded that similar results could be obtained by examining adjacent spatial cases during the 2020/2023 pandemic for the E.U.-27, such as Italy versus France, and the European Economic Area (E.E.A.), for example, Sweden versus Norway.

Discussion

The results of this initial trial analysis on daily data are significant. It is important to note that any restriction due to, for example, hospital problems leads to a decrease in tourist arrivals and, more importantly, a change in tourist numbers and habits. If we measure the pure economic impact, the COVID-19 epidemic is probably the most profound breakdown reflecting G.D.P., while tourism contributes about 20% to the entire national economy in Croatia and 5% in Slovenia (Gričar, Šugar et al., 2021).

The results of this study suggest that econometric analysis on daily data does not provide satisfactory results, and therefore Gričar's (2019) *ex ante* research on monthly data provides comparative results. This study is the resonance that COVID-19 research on time series is limited at the moment and should be continued with some other modelling structures. One of the ways is the panel regression done in this study.

The modelled results of this study do not confirm an apparent relationship between COVID-19 infection and the number of tourist arrivals. The conclusion is that COVID-19 does not have as egregious an impact on tourist arrivals as is usually portrayed in newspapers and some scientific articles (Table 1). The scientific implications of this study suggest the need for a comprehensive study focused on discovering other determinants affecting tourist arrivals during the pandemic from late 2019 to late 2021. On the other hand, some other methods, such as C.V.A.R. and cointegrated panels, should be used to isolate barriers in the regression. Therefore, C.V.A.R. and random panels are better choices. C.V.A.R. has many ways to nest a multivariate path-dependent process of data emergence and a corresponding dynamic macroeconomic theory. The k-th order V.A.R. is:

$$x_t = \mu_0 + \Pi_1 x_{t+1} + \ldots + \Pi_k x_{t-k} + \varepsilon_t, \ \ t = 1, \ldots T, \tag{11}$$

where ε_t is $NI_p(0, \Omega)$ and $x_0, \ldots, x_{-k+1}$ are predetermined. Although, when the reviews of x_t are actively time-dependent, the conditional process $(x_t | X_{t-1}^0)$ is independent and O.L.S. estimates of $\{\Pi_1, \ \ldots, \Pi_k, \ \mu_0, \ \Omega\}$ are Maximum Likelihood estimates. The example V.A.R. is thus an econometric metamorphosis of (time-invariant) data covariances. Therefore, it can be used as a first general approximation to the real process of data formation (Hendry & Mizon, 1999).

Conclusions

Shocks in tourist arrivals due to viral infections and emerging diseases are validated events. They are confirmed as one of the significant uncertainties and threats to the tourism industry. This study analyses the relationship between the current pandemic COVID-19 situation and tourist arrivals based on a daily data vector. E.C.D.C. reports the positive cases or diagnoses.

In summary, first, the COVID-19 pandemic has no significant direct impact on tourist arrivals in the short term, but the impact is indirectly significant. There are also other determinants not included in this study, influencing lower tourist arrivals in 2020. The results are based on daily data from March 5, 2020, to December 14, 2020. Second, the *ex ante* investigation on monthly data for the long-term period provides the information that viruses negatively affect tourist arrivals and bacterial infections positively. The latter could be the next reverberating outbreak in tourist arrivals.

The suggestion to policymakers is to be more concerned with the dissemination of diagnosis, also during the pandemic and in the EU, diagnoses are subject to privacy policy restrictions. On this occasion, sharing this information with the public, tourism management, and the police is a misleading solution. As reported in this study, tourism has suffered and will continue to suffer due to various diseases and policy decisions. The recent epidemic is changing the solution to the welfare of residents, tourists and others across generations. While bacterial infections can be managed in countries as a whole without significant negative impacts on tourist arrivals, this is less the case for viral infections and pandemics with broader governmental policy decisions.

In conclusion, the results propose to study several determinants that influence tourism arrivals while the direct impact on the decline in tourist arrivals due to the COVID-19 epidemic was not confirmed, and therefore, the hypotheses are not verified. The spatial analysis based on the panel regression reveals some differences in Croatian and Slovenian tourism market impacts. Whether public or private, the tourism industry should strongly collaborate and network with the health system and policy/decision-makers. This information can be supported by improving staff awareness and training, accurate information, and first-aid posts for tourists. The historical data presented in this research could improve the thinking of decision-makers and tourists.

The opportunity for future research are delimitations and limitations of the study. The delimitations are that we focus on two Mediterranean countries and a defined data vector. Nevertheless, the data vector is as long as possible for the research time in March 2021, while CBS (2021) does not report tourist arrivals for the period after December 2020. Limitations of the study include testing the hypotheses for waves in a regression function. Therefore, topics for future research could include incorporating integrated time series analysis into a cross-country comparison or random panel data analysis. One possibility could be the application of predicting tourist arrivals with genetic programming models using different explanatory variables.

Overall conclusion

The main hypothesis is that the tourism industry in Slovenia and Croatia has developed rapidly and is expected to grow even more in a positive direction and year-round (not seasonal). This is an opportunity for positive and more productive growth? Therefore, the Slovenian and Croatian tourism industry offers an exciting research question focusing on a strategic approach using time series: H1: In the short run, tourist arrivals in Slovenia decline due to the COVID-19 pandemic. H2: In the short run, tourist arrivals in Croatia decline due to the COVID-19 pandemic.

However, several factors need to be integrated with this overall conclusion:

1. the models (O.L.S., V.A.R. and Panel) do not prove the direct impact of COVID-19 on tourist arrivals;
2. the government and policymakers influence the impact on tourist arrivals;
3. impact studies on other country pairs would yield comparable results of the first (methodology) and second determinant levels (policymakers);
4. structural breaks were expected; therefore, several methodological steps were introduced from the beginning.

Nevertheless, the time series methodology step is crucial in multivariate analysis.

Disclosure statement

No potential conflict of interest was reported by the authors.

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9.4 ATTACHMENT 2.

Sustainable determinants that affect tourist arrival forecasting

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Sustainable Determinants That Affect Tourist Arrival Forecasting

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Abstract: This study considers diversification effects and significant influences on tourist arrivals as a vital export direction. Different quantitative methods, namely a cointegrated-autoregressive model, panels, sentiment and sensitivity analysis, were used in this study. The time-series data for Croatia and Slovenia were isolated from several secondary sources. The variables examined in this approach are tourist arrivals, precipitations, sunny days, earthquakes, microbes and CO_2 emissions. The study results showed that there is a severe negative effect on tourist arrivals defined by viruses. Moreover, there is a significant decisive effect of weather conditions on tourist arrivals. Nevertheless, it is necessary to move past Covid-19 pandemic discussions to yield more accurate tourism supply forecasts, while demand is already somehow low since the beginning of 2020. The primary significance is to develop a broader thinking about the impacts of CO_2 emissions on the tourism escorted to official tourist websites.

Keywords: cointegration; Croatia; external factors; Slovenia; tourist arrivals; vector autoregressive model

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1. Introduction

The importance of tourism in small, open economies has been widely studied. It is vital to add environmental aspects to influence tourism demand and supply, confirming tourist arrivals. Tourism on the Adriatic coast has a long tradition. Moreover, in Croatia and Slovenia, the two central European tourist destinations, it is given special treatment by the government and the residents. Undoubtedly, these two countries are among the major players in European Union (EU) tourism, accounting for 6.63% of international tourist arrivals in 2019. To better understand the idea of our research, it should be noted that tourist arrivals in Croatia and Slovenia account for one-fifth of all tourist arrivals in Central Europe and the Baltics [1]. Finally, the majority of the internal tourism is not yet sustainable, and, undoubtedly, tourist seeks nice weather.

Since late 2019, tourism has experienced a crisis [2], and the vast majority of researchers [3] have been concerned with the idea of what tourism will look like after the Covid-19 pandemic [4]. It is foreseeable that the solipsism of everyday impact on the environment will be crucial for future tourism demand and, more importantly, for the supply [5]. The changes cannot be overlooked, and researching them is essential. This study examines secondary data on tourism and the environment, including microbes, following the idea of Gricar [6], who predicted the decline in tourist arrivals beforehand. On the other hand, microbes could have a significant positive effect on tourist arrivals. While some authors [7] are very sceptical that such a reset or transformation is likely as we emerge from the pandemic, others are indeed more optimistic, as shown by a literature review collage [8]. What is of great importance is that the thought, analysis and imagining of the possibilities do occur. Sustainability, justice and fairness are not easy to give; they must be fought for and won [9].

Therefore, this is the first research that looks at the mixed type of pandemic and environmental variables to investigate the impact on tourist arrivals for a country or a pair of neighbouring countries. It is worth mentioning that this research does not address the effect of tourism on the environment, but vice-versa. The effect of the ecosystem (biotopes and biocenosis) [10–12] on tourist arrivals is essential for a sustainable tourism growth. Tourism strategies based on past models, like the three S model (sand, sun and sea), gastro tourism [13] or heritage, should be withdrawn to understand better the future dimensions of shocks, habitats and habits [14]. First, regarding the overwhelming surprises, strategic planning is crucial. Management planning should include, for example, three large global earthquakes that are likely to happen simultaneously in 2021, as reported by the authors [15]. After that, there are ongoing climate changes [16], economic threats on human neurocognitive processes [17], other economic threats [18], epidemics [19], wars connected to the post-9/11 era [20] and other threats that could be revealed by the data [21].

Second, the tourists should respect and understand natural habitats in order not to experience inconveniences or life-threatening agents such as mosquitoes [22], microbes [23] and other natural threats [24]. Finally, the pattern of tourism supply should dramatically change to reflect the new dimensions in advertising [25] and offer systems for a sustainable demand routine [26]. Overall, the economic crisis that began in 2008 [27] and the pandemic that started in 2020 have reduced supply and demand [28]. The destination management should be sustainable and not just aim to meet the tourists' needs [29]. In a nutshell, the extension of the nature shocks should be emphasised when planning tourism extensions, development and new perspectives. Economic forecasting should take into consideration all crucial variables in order to be as accurate as possible [30]. Therefore, the purpose of this paper concerns the issues of an unexpected rise in infections and diseases impacted by urbanisation (cars and concrete) and climate change [31] for sustainable tourism development.

In spite of all the mentioned shocks, tourism could be sustainable in the future [32], as services are of great importance in contemporary life and contribute to human well-being [33]. Moreover, the 17 Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity [34]. Some forms of tourism associated with the SDGs, such as low-carbon tourism [34–36], nomadic tourism [37–39], individual tourism with discrete individual tourist systems [40] and sustainable tourism [41,42], are used as independent variables in this study, while tourist arrivals are the dependent variable [43]. In analysing Croatian and Slovenian [43] tourism further development in the long run [44–46], the imperishable employees, as well as the tourism science competencies and the everlasting tourist should be considered as key elements where a shock [47] or an interruption of rain [48] or a crisis [49] should not be crucial development issues.

If things change in Croatia and Slovenia, the non-seasonality of tourist arrivals [50] will bring higher revenues [51], higher expenses, lower seasonal waves and a sustainable approach to the domestic market [52–54].

Following the above statement and an extensive and exhaustive literature review [55–62], in which only one study [63] developing the objective of an increased sustained influence of sustained determinants [64] on post-pandemic tourism was found [65–67], the state-of-the-art hypothesis was developed. It also includes an outstanding methodological significance: a sustainable human management of the climate and ecosystems would significantly increase tourist arrivals in Croatia and Slovenia and reduce seasonal volatilities. Several subordinate-mentioned independent variables are determined to investigate the new normal [68,69].

Thus, the goal of this manuscript is twofold. First, to provide an overview of the empirical literature on the direction of tourism vs sustainability research. Second, to highlight the growing general trends in the field of tourism sustainability. In addition, it is of great importance to investigate their impact on tourists' decision-making when choosing their destination and to highlight future trends. The researchers will evaluate at least 100 recent manuscripts published in reputed journals and publications of renowned public institutions.

On the other hand, the second goal provides multiple aims to test the hypothesis of the paper. Therefore, the first objective focuses on the variables researchers will include to determine the potential increase in tourism after the pandemic. The second objective identifies the increasing demand for differentiated tourism, including environmental and ecosystem variables. Croatia and Slovenia receive the majority of tourists from the closest north and west countries as leisure tourism: social, family and nature tourism, but also a growing trend of culinary, eco- and agro-tourism. Finally, this is the opportunity to investigate how weather conditions might influence this tourism trend in the two countries. Per the objectives, the quantitative time series method is used.

The arrival of individual tourists is one of the emerging phenomena in the tourism community. At the same time, agencies failed their clients during the Covid-19 pandemic, since large groups of tourists are undesirable because of the mandatory social distancing. All parameters of the pandemic will continue until the deep end of the current pandemic, in 2021/2023 [70,71], unless another pandemic occurs or continues until then [72]. Therefore, the statistical data should be collected so that the tourist arrivals are differentiated as individual or group visits, which is not the case now. Or, even better, by their arrival status, e.g., whether they arrived independently or in a group and whether a group was organised by a third party [73,74]. It is of enormous importance to have such data to study the effects and the relationships between variables. Tourist arrivals are a well-researched area in tourism science, but the vast majority of researchers consider these data as economic impacts and vice versa [75]; thus, the research topic of external and sustainable environmental threats on tourist arrivals is of great importance [76]. Overall, research PDQ (directly) refers to the tourist arrivals to better understand the obstacles that affect seasonality and sustainability [77].

Precipitation in millimetres of rainfall is the second factor researched and measured and the first independent variable in a collage of determinants affecting tourist arrivals as a dependent variable. A limited number of studies have been conducted considering this parameter. Perhaps the most prominent one was recently published for the mountainous regions of South Asia [78], where the authors identify a unidirectional causality from precipitation to tourist arrivals. The cornerstone is the result of [79], which shows that the amount of precipitation represented by rainfall negatively affects tourist arrivals in both the short and long term. Overall, meteorological variables are used to predict tourist arrivals in different destinations and regions, such as the Balearic Islands [80], the Pacific [81], the Philippines [82], Italy [83], Zanzibar and Tanzania [84].

The third independent variable—identified as a factor for potentially shaken tourist arrivals in the future, not scientifically researched enough and combined with tourist arrivals—refers to earthquakes. For Croatia, after several devastating earthquakes and judging some previous results [85,86], extending the season [87] in terms of dark tourism [88] is a real possibility. At the same time, the authors found the "fortune cookie" effect when the growth of total inbound tourist arrivals to Sichuan and Nepal after earthquakes increased. It is worth noting that the catastrophic earthquakes [89] in Croatia, starting with the one in Zagreb in early 2020 [90], just as the pandemic began [91], as well as several others in the country [92], could be significant tourist attractions [93,94] in terms of dark tourism.

The number of sunny days is an important aspect that determines tourism demand [95] and the imbalance between supply and seasonality [96], which is widely recognised [97]. However, few researchers are investigating this phenomenon as an independent variable in time series data science [98]. An earlier study found that sunny days differentiate between tourist segments to an increased number of tourist arrivals [99,100]. Therefore, Croatia and Slovenia may recognise the extension of their season from cloudy weather with less sunshine in late spring and early autumn [101]. Overall, the issue of whether sunny days are an essential variable in increasing tourist arrivals or determining seasonality [102] is debated when examining the results of this contemporary research.

Before the last independent factor, there are "microbes" that have been publicly described ex post, but which were less likely ex ante, before the Covid-19 pandemic. As a consequence of increased tourist arrivals in certain mountain regions, the secondary bacterial infections were reported [103]. Nonetheless, it is crucial to widely determine microbe threats for the tourism industry, like HIV or a brand new germ [104,105].

The last studied phenomenon that serves tourist arrivals is the idea of zero-emissions of carbon dioxide (CO_2). Contemporary tourists already choose green destinations over the smoggy ones [106,107]. Therefore, the idea is to study the opposite data, where tourist arrivals are a dependent variable instead of previous research where tourist arrivals were treated as an independent variable [108]. Overall, this variable escalated as a calculated bump in this research, while trending researchers found determinants, i.e., island travel, crisis or commuting, affecting carbon footprint [109–111]. In the EU 2030 climate and energy strategy, there are three main objectives: (1) to reduce greenhouse gas emissions by 40% (compared to 1990), (2) to increase the share of renewable energy by 32% and (3) to improve energy efficiency by 32.5%, which counts towards the overall 40% emissions reduction target [112].

The remainder of the paper is organised as follows. The following section presents the methodology and data used in the study. In the third section, the main empirical results and findings are explained. Finally, after the discussion regarding the research objectives and the hypothesis development, the most significant conclusions are provided.

2. Materials and Methods

A systematic review of previous empirical and theoretical studies has revealed that most studies have been conducted for Asian countries, where the world's urbanisation burden is the highest. Nevertheless, precipitation and sunny days seem essential for European countries, the sparsely populated Alps and the Mediterranean region. Based on an extensive literature review, the paper discusses the methodological challenges in exploring the influence of ecosystem changes on destination choice. The researchers examined more than 100 published articles, looking for a keyword that indirectly relates to the present study. In terms of the econometric analysis, simple summary statistics is a primary method to obtain the initial information of the observed data and present the indexed results of the levels.

Given the hypothesis, the data vector in (1):

$$\Delta^{\mathrm{HR,\,SI}}[\mathrm{ARR}\cdot\mathrm{RAI}\cdot\mathrm{QUA}\cdot\mathrm{SUN}\cdot\mathrm{MIC}\cdot\mathrm{CO_2}]_{t-1}, \tag{1}$$

provides the variables on short notice. Data were collected from secondary sources provided by national offices and other eminent national [113,114] and international institutions [115,116], as presented in Table 1. The abbreviation HR stands for Croatia and SI for Slovenia. It is crucial to produce a credible study using modern econometric tools. Therefore, the data origin and availability is presented in Table 1. The period studied in this research refers to daily, monthly or yearly sequences [117].

Table 1. The data source of the variables used in the econometric research.

Variable	Abbreviation	Source	Availability
Tourist Arrivals	ARR	Eurostat [118]	December 1999–March 2021
Precipitation	RAI	WBG [119]	January 1991–June 2021
Earthquakes	QUA	USGS [120]	December 1999–June 2021
Cloudiness	SUN	WMO [121]	January 1901–December 2018(9)
Cloudiness	SUN	CMHS [122]	January 2011–June 2021
Microbes'	MIC	ECDC [123]	January 2014–December 2019
Microbes'	MIC	NIPH [124]	January 2008–December 2019
Carbon dioxide	CO_2	GML [125] [1]	March 1993–December 2019

Source: Different organisations. Source location: [1]—at Hegyhatsal, Hungary (HUN).

Looking at the cross-section of all available data, the final decision on a data range is from December 1999 to March 2021. In contrast, some information about the selected variables is presented below in (2), and the main data vector is:

$$\Delta\{^{HR, SI}[ARR{\cdot}RAI{\cdot}QUA{\cdot}SUN]\,^{HUN}[CO_2]\}_{t-1};\ t = 1, 2, \ldots\ T;\ T = 256;\ T = 1999M12, 2000M01, \ldots, 2021M03, \tag{2}$$

based on obtained, isolated or calculated monthly data. The abbreviation HUN stands for Hungary, and T is the number of observations for time t.

The supported data vector contains MIC, but the period is shortened due to the lack of data for MIC. Therefore, the supported data vector, which is analysed in the separate section, is in (3):

$$\Delta\{^{HR, SI}[ARR{\cdot}RAI{\cdot}QUA{\cdot}SUN{\cdot}MIC_{(VIR\ BAC)}]\,^{HUN}[CO_2]\}_{t-1};\ t = 1, 2, \ldots\ T;\ T = 72;\ T = 2014M01, 2014M02, \ldots, 2019M12;\ n = 1, 2 \tag{3}$$

where the abbreviation VIR stands for viruses and BAC for bacteria.

Consistency across variables is one of the advantages of a multivariate data set, which provides the ability to present, at a point in space and time, a set of variable values that are (to some degree) internally consistent. Such a step explains much of the variable production design: the ecosystem variable ARR is a dependent variable examined so it can identify the future benefits and weaknesses that determine tourism demand (pull effect). For zero ARR in Slovenia in April 2020 (Covid-19 lockdown), the missing value is replaced by the number 1.

By contrast, the independent ecosystem variables MIC and the environmental variables RAI, QUA, SUN and CO_2 have the same effect as tourism supply (push effect). The predictable result should be significant and is explained in the Results and Discussion section, while the previous empirical literature recognises singular influences. However, conducting an additional homogenisation of the dataset would be complicated due to elements such as published data. Low data coverage in some regions or for some variables is a limitation to applying neighbourhood-based homogeneity tests where some degree of homogenisation has been implemented. The multivariate nature means that homogeneities identified in mean MIC data are, for example, likely to affect other variables. Details on the source of the specified variables and homogeneity are provided in the following six paragraphs.

Eurostat and national statistical offices from a monthly dataset as a value of domestic and foreign tourists isolate the data for the variable ARR in a defined month. The values of zero events are logically numbered as 1.

The World Bank Group (WBG) Climate Change Knowledge Portal collects the data for the variable RAI on a monthly average of millimetres for the specified country.

The data for the variable QUA is obtained on individual cases from the U.S. Geological Survey (USGS) and calculated on a monthly number of observations. The months without a case of the earthquake have a value of 0.1.

SUN is used from the average monthly cloud cover factor [126]. By contrast, the World Meteorological Organization (WMO) catalogue for Climate Data covers the entire study period for Slovenia. For Croatia, the data availability is until December 2018. The missing observations from January 2019 to March 2021 are collected from the Croatian Meteorological and Hydrological Service (CMHS) using the equation specified in (4):

$$1 - (x/(y \cdot d)), \tag{4}$$

where 1 is the inverse function of a solar day, x is the cumulative hours of full sun per month, y is the maximum sun per day, and d is the number of days in the month, February having the matter of average days equal to 28.25. Overall, the data are for the Slovenian capital, Ljubljana, and for Croatia's second-largest city, Split. The choice of cities (location/destination) was made based on tourist preferences, where the Adriatic coast (Croatia) and the capital (Slovenia) are among the most popular destinations in the world.

The data for the variable MIC is obtained from two different sources: the National Institute for Public Health of the Republic of Slovenia (NIPH), which provides monthly data for Slovenia, and the European Centre for Disease Prevention and Control (ECDC), for Croatia. The annual data for Croatia are averaged per month without factor weighting. The MIC will be generally excluded from the analysis while data coverage is short. The possible significant impact will be studied and considered separately.

CO_2, an all-too-human foible, is isolated in the monthly data set from GML, whose nearest reported monitoring site is in Hungary. The observatory is located on the border between Croatia and Slovenia, making it the closest observatory to provide accurate monthly data on CO_2 [127]. The data are credible, while the differences in volatility (not the amount per million (ppm) tones in the values) are similarly unsettled as those worldwide.

Croatian CO_2 emissions from significant point sources amount to about five ppm per year. The conservative estimate for storage capacity in aquifers and hydrocarbon fields is three ppm CO_2. In this respect, Croatia's storage capacity far exceeds its CO_2 emissions, compared to the total emissions from primary point sources, with conservative estimates of storage capacity of 580 years. The storage capacity estimates are based on storage efficiency factors, surface area, thickness, porosity, etc. Depending on the ranges of calculation parameters used, the lowest and highest values are obtained. The conservative estimate for aquifer storage capacity for Slovenia is 92 ppm CO_2, while the optimistic value is above 500 ppm. Slovenian CO_2 emissions from significant point sources are about 7 ppm per year, and, therefore, the available Slovenian storage capacity is sufficient to store all CO_2 [128].

The Global Monitoring Laboratory (GML) reported some details about the countries under study (Figure 1). The Republic of Croatia (Figure 1a) (HR) is one of the countries within the Adriatic-Mediterranean and Pannonian-Danube regions in Central Europe. Croatia is very sensitive to the impacts of climate change (oceanic temperature climate (spring bud (green) colour)) and sub-polar oceanic climate (dark pastel green colour), as shown in Figure 1a).

The Republic of Slovenia (SI) is located in Central Europe (Figure 1b), and the length of the coast is slightly less than 50 km. The climate in Slovenia is exceptionally diverse. It ranges from oceanic temperature climate (spring bud (green) colour) to sub-polar oceanic climate (dark pastel green) and warm-summer humid continental climate (middle sky blue colour) Figure 1b. Additionally, it has a wide range of local climatic conditions, while tourism counts for around 5% of GDP.

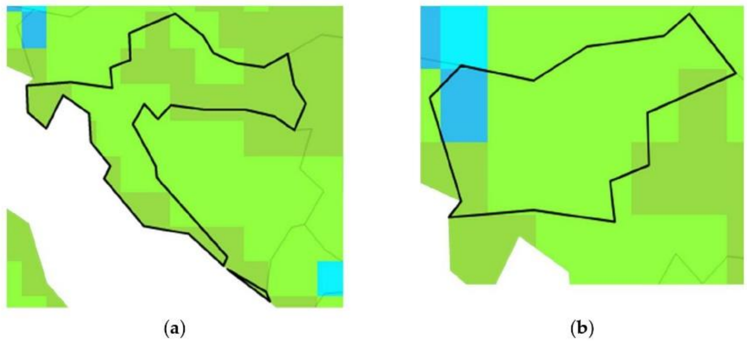


Figure 1. Köppen–Geiger Climate Classification, 1991–2020 (**a**) Croatia; (**b**) Slovenia.

The motivation for this research arose from the attempt to develop a combined vector autoregressive model (CVAR) and a panel discussion on tourism. While the United Nations World Tourist Organisation (UNWTO) has predicted the increase in tourist arrivals without interruption, but in seasonal time-series, this is a misleading idea [129]. Therefore, the sensitivity analysis will give additional input to check the robustness of the results. Finally, other variables that determine tourist arrivals, such as environmental and ecosystem, besides the obsolete microbes, will be included in the study (Table 1) for Croatia and Slovenia. Overall, the study aims to broaden the European discussion on zero emissions in tourism. At the same time, it is crucial to verify the meaning of the information behind the figures collected by different organisations. Nevertheless, this study has a significant added value, while the embedded sentiment analysis represents a significant scientific contribution to the tourism science. Due to the lack of similar studies, a separate subsection will focus on the meaning of the relevant information on the global supplier's website.

It is essential to show that past events generate future trends. Hence, CVAR econometrics is an integral part of the scientific approach to become familiar with the dispersion of data. The importance of tourism to the national economy is enormous, and policy-makers are recognised as relevant tourism industry partners. Therefore, the current research presents some aspects for further development on sustainable determinants affecting seasonality, accompanied by VAR, to identify the recent shocks that could explain the future downturn in tourism. The CVAR model is a recognised method that allows us to discover sameness in secondary quantitative time-series data. It is an econometric tool used to explore ideas that are hidden but predictable. Overall, before the sensitive and sentiment analyses, the proposal of secondary data collection and its calculation are supported by the VAR model [130].

The learning process can be based on the manual or automatic feeding of the knowledge base by developers based on user logs. Social media content is becoming increasingly essential to identify emerging trends. In this scenario, sentiment analysis has been adopted to study emotions and analyse reviews and ratings [131–133].

Sentiment analysis became popular during the pandemic while the information on tourist websites regarding actual data was not accurate and up to date [134]. Applied sentiment analysis on Twitter has measured customers' perceptions about their hospitality experience. Facebook has also been used as a source to analyse users' comments on the hospitality industry. It is compared to a machine-learning and a lexicon-based analysis method to sentiment analysis, discovering that their results are comparable and thus indicating the easiness of using sentiment analysis compared to other methods. Moreover, the simplicity in moods classification–positive, negative or neutral–suggests that sentiment analysis results should always be joined to different approaches. Anyway, the information obtained thanks to this approach provides excellent support in decision-making when defining new or reactive (to unpredicted events) strategies.

3. Results

Plotting the data at this stage is crucial in dealing with secondary data, while precluding the obstacles to the regime is a necessary econometric step in dealing with normality. The data obtained in the levels were:

- First, transferred to the Excel spreadsheet;
- Calculated, to monthly observations;
- Chained indexed (CI) in (5);

$$1.\ \mathrm{CI} = \mathrm{X_t}/\mathrm{X_{t-1}} \cdot 100, \tag{5}$$

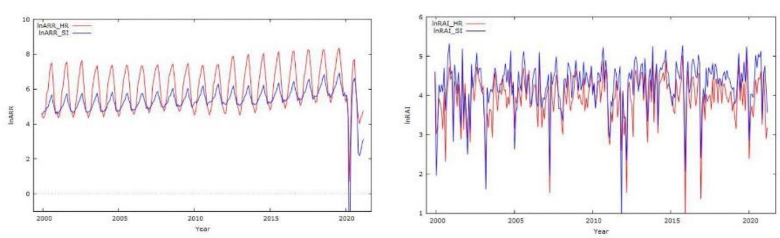
where $\mathrm{X_t}$ is the present month, $\mathrm{X_{t-1}}$ is the previous month;
- Indexed (I) to a constant base in (6),

$$2.\ \mathrm{I} = \mathrm{CI_t} \cdot \mathrm{I_{t-1}}/100, \tag{6}$$

where I for 1999 is 100 (1999 = 100) and $\mathrm{I_{t-1}}$ is a past index with a constant base;
Finally, the data were logarithmised and differentiated.

3.1. Familiarisation with the Data—Data Plotting in Logarithms

The need for the dispersion of data is well known in time series. Therefore the results of this step show that the obstacles are predominant in Slovenian tourism, while Croatian tourism has fewer shocks (Figure 2a). The most obvious one is the outbreak of the Covid-19 pandemic; therefore, treating these results pushes the researchers to obtain dummy variables in the other processes. On the other hand, the precipitation in Slovenia and Croatia has similar patterns (Figure 2b).



(**a**) (**b**)

Figure 2. Spatial analysis in logarithms (ln): (**a**) tourist arrivals (ARR); (**b**) precipitation (RAI). Note: The abbreviations of variables are presented in Table 1. Source: Table 1 and data vector; authors calculations.

The following spatial differences are related to the fact that fear is maintained during natural disasters and calamities. For example, Figure 3a shows that many earthquakes occurred at the beginning of the century. By contrast, the scarcity stops with the increase of events in this decade. The economic depression of 2007/2008 did not affect these types of disasters, while economic growth may have prevented the new wave of disasters that began with the Covid-19 pandemic. However, this is a hypothetical question rather than a stable result based on Figure 3a. In contrast, Figure 3b shows that CO_2 emissions increased throughout the period.

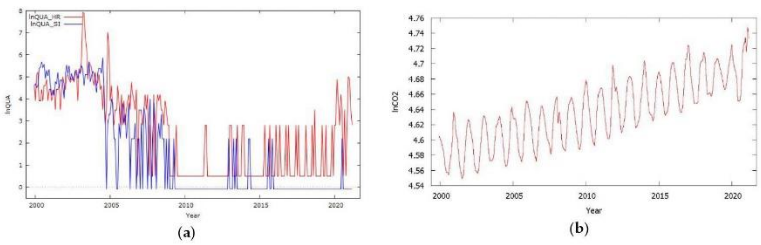


Figure 3. Spatial analysis in logarithms (ln): (**a**) earthquakes (QUA); (**b**) carbon dioxide (CO_2). Note: The abbreviations of variables are presented in Table 1. Source: Table 1 and data vector; authors calculations.

Based on the graphical design of the data in the logs, the next step in the initial analysis is to review the summary statistics. Overall, cloud cover was not represented by spatial differences in the figures, but it has an opposite effect as precipitation.

3.1.1. Data Overview

When introducing summary statistics in Table 2, the results confirm the figures, on the one hand, and add information indicating that all variables should be treated in differences; on the other hand, the normality distribution is based on skewness (standard value around 0), and kurtosis (expected value around 3) is exceeded.

Table 2. Summary statistics, using the observations 1999:12–2021:03, December 1999 = 100.

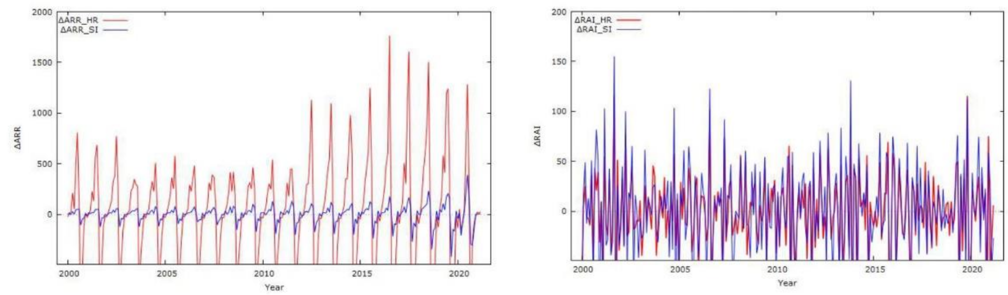
Variable	Mean	Median	Minimum	Maximum	Skewness	Ex. kurtosis	Std. Dev.
ARR_HR	780.24	399.89	1.98	4168.20	1.77	3.00	873.88
ARR_SI	252.13	212.29	0.0009	1007.40	1.83	4.70	152.38
RAI_HR	58.79	54.89	2.601	152.31	0.55	0.33	28.02
RAI_SI	82.97	81.81	2.2753	204.99	0.48	0.19	39.709
QUA_HR	71.07	16.67	1.67	2766.70	8.68	82.75	260.24
QUA_SI	40.13	0.91	0.91	354.55	1.92	2.80	72.42
SUN_HR	80.59	81.10	21.28	138.30	−0.21	−0.60	24.83
SUN_SI	76.61	76.60	38.31	116.42	0.08	−0.64	17.11
CO2_HUN	103.35	103.10	94.60	115.31	0.19	−0.66	4.52

Note: The abbreviations of variables are presented in Table 1. Source: Table 1 and data vector; authors calculations.

The highest volatility is in ARR and QUA for Croatia; by contrast, the lowest deviation is in CO_2 (Table 2). Similarly to Croatia and Slovenia, ARR and QUA are responsible for most of the differences in the data.

3.1.2. Data Plotting in First Differences

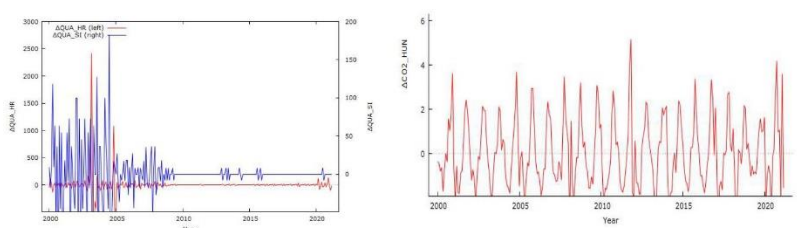
To get the most out of the data, plotting in first differences is essential. Plotting allows us to conclude that volatility and seasonality are prevalent in Croatian tourism, while Slovenian tourism shows a more stable volatility in tourism demand (Figure 4a). This step is vital to see the data distribution, while it is much easier to see obstacles in the first differences than in the levels. On the other hand, precipitation is less stable in Slovenia than in Croatia (Figure 4b).



(**a**) (**b**)

Figure 4. Spatial analysis in the first differences: (**a**) tourist arrivals; (**b**) precipitation. Note: The abbreviations of variables are presented in Table 1. Source: Table 1 and data vector; authors calculations.

Overlaying the images in Figure 5, one might conclude that there are new waves of disasters. At the beginning of the century, there were severe earthquakes in Croatia and Slovenia; on the other hand, carbon dioxide volatility was higher than in the economic expansion from 2016 to 2020. Overall, carbon dioxide volatility decreases again with crises, the Covid-19 pandemic and severe earthquakes in Croatia, starting with the one in Zagreb in March 2020. Seismicity is a hypothetical issue rather than a stable result based on Figure 5a. Nevertheless, Figure 5b confirms this statement. At the same time, in the sound economic period, when there were less earthquakes, the volatility of CO_2 emissions was higher than in the period with higher ppm amounts. Therefore, we can conclude that these two natural objects are diametrical.



(**a**) (**b**)

Figure 5. Spatial analysis in the first differences: (**a**) Earthquakes; (**b**) Carbon dioxide. Note: The abbreviations of variables are presented in Table 1. Source: Table 1 and data vector; authors calculations.

Based on the graphical designing of the data in differences, the next step of the initial analysis is run to check the autocorrelation. Additionally, the heteroskedasticity and normality of the variables in a VAR model is the primary treatment. Overall, the cloudiness of spatial differences was not presented in the figures while it has an opposite conclusion, like precipitation.

3.2. Results of VAR

The VAR model is a widely used method with several significant results, that could provide credible results. The calculation from the data suggests dummy variables. If one plot all the time series (Figure 6), the most obvious ones are April 2020 and May 2020 for ARR in Slovenia, so this is a transitory blip dummy Dtr,t = [0,0,0,1,–1,0,0,0]. The added form means that ARR was removed for one month and gradually restored in the next month.

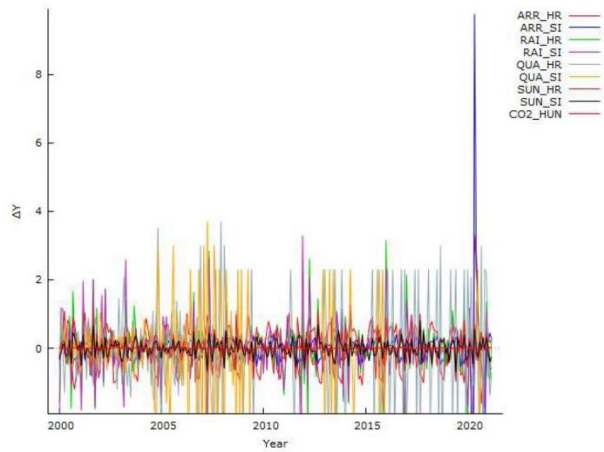


Figure 6. Illustrating a mean shift. Note: The abbreviations of variables are presented in Table 1. Source: Table 1 and data vector; authors calculations.

The estimated residual covariance matrix is shown in Table 3, where the most significant coefficients are the spatial dimensions and the correlation with carbon dioxide. Therefore, further analysis is essential, while for time series, the coefficient should be as low as possible to obtain normally distributed residuals. Therefore, several other seasonal, permanent, shift or transitory dummies are needed. At the same time, the additional performance of the misspecification test shows that only the weather variables have no ARCH effect, and the residuals are more normally distributed, accompanied by carbon dioxide. Therefore, such a model has four cointegration relations based on the Johansen trace test.

Table 3. Correlation matrix.

ARR_HR	ARR_SI	RAI_HR	RAI_SI	QUA_HR	QUA_SI	SUN_HR	SUN_SI	CO_2	
1.0000	0.6665	−0.0088	0.0959	−0.0134	0.0520	−0.3047	−0.2300	−0.7028	ARR_HR
	1.0000	0.0154	0.0482	−0.0172	0.0137	−0.0012	0.0480	−0.1907	ARR_SI
		1.0000	0.8888	−0.0522	−0.0267	0.6390	0.6248	−0.0007	RAI_HR
			1.0000	−0.0268	−0.0647	0.4891	0.4971	−0.1451	RAI_SI
				1.0000	0.0009	−0.0456	−0.0661	−0.0277	QUA_HR
					1.0000	0.0204	−0.0079	0.0117	QUA_SI
						1.0000	0.7499	0.3136	SUN_HR
							1.0000	0.3446	SUN_SI
								1.0000	CO_2

Note: The abbreviations of variables are presented in Table 1.

The model's misspecification tests (Table 4) rejected the null of residual normality and no autocorrelation for some variables. Moreover, the cross-correlogram showed significant correlations between the errors, which are assumed to be independent. Thus, the first set of diagnostic tests showed a clear violation of the accepted distributional assumptions. Therefore, the assumed probability model is not correctly specified; the reported statistical inference is not Maximum Likelihood, and the p-values calculated from standard normal distributions may be completely unreliable. The misspecification test of homoscedasticity and the normality test, accompanied by the Dickey–Fuller (ADF) test of autocorrelation, in Table 4, for each variable, separately show that the inventory variables are needed. In the right part of Table 4, the indices' distribution is conducted to understand the data's characteristics better. At the same time, we checked whether the distribution of the index in terms of height resembles a normal distribution.

Table 4. Misspecification tests and VAR.

Variable	ADF Test (Δ)	ARCH LM Test	Dummies	Jarque–Bera Test	Decision
ARR_HR	−5.52 *** I(1)	74.99 ***	$D_{tr,t}$	2.04 (−0.20; 3.20)	lnARR_HR
ARR_SI	−3.28 ** I(0)	177.17 ***	Trend, constant, $D_{tr,t}$	205.43 (−0.85; 7.06)	ΔARR_SI
RAI_HR	−14.67 *** I(0)	6.41	Constant	3.31 (−0.08; 3.53)	ΔRAI_HR
RAI_SI	−8.08 *** I(0)	25.89 *	Constant	6.72 ** (−0.26; 3.60)	ΔRAI_SI
QUA_HR	−3.88 *** I(0)	102.86 ***	/	1.14 (−0.16; 3.12)	lnS_tQUA_HR
QUA_SI	−5.89 *** I(1)	88.84 ***	/	38.65 *** (0.86; 2.12)	lnQUA_SI
SUN_HR	−3.66 *** I(0)	38.25 ***	Constant	2.42 (0.13; 2.60)	ΔSUN_HR
SUN_SI	−4.74 *** I(0)	21.28 **	Constant	0.16 (−0.04; 2.92)	ΔSUN_SI
CO2_HUN	−4.49 *** I(1)	206.97 ***	/	5.81 ** (−0.10; 2.29)	lnCO2_HUN

Note: The abbreviations of variables are presented in Table 1; $D_{tr,t}$—transitory dummy for the Slovenian hotels closed between April 2020 and May 2020; data in brackets—(skewness; kurtosis;); ln—logarithm; Δ—one difference level; S_t—seasonally adjusted; *** significant at 1%; ** significant at 5%; * significant at 10%.

ARCH LM test for heteroskedasticity uses integration data based on the statistics of the ADF test. Since it is known that the singular ADF test is not sufficient, the supported tests were performed, along with the well-known Jarque–Bera test for the goodness-of-fit. Based on the skewness and kurtosis of the distribution of the variables and depending on the height, it is a sizeable non-asymmetric distribution in most cases. Nevertheless, depending on the econometric model in 2 and based on the results of the misspecification test, the last column in Table 4 presents the decision whether to use the variable in the VAR model. The VAR model is constructed as follows. The Croatian ARR has a logarithm and a transitory dummy (0, −1, 1, 0) for April 2020 (−1) and (+1) for May 2020. This variable has only the residuals normally distributed (skewness is −0.20 and kurtosis is 3.20). On the other hand, there may be some seasonal heteroskedasticity. The decision for other variables is as follows:

- Croatian ARR is near I(0) with a transitory dummy (0, −1, 0, 0) for April 2020 (−1) and (+1) for May 2020;
- Slovenian ARR is near I(1) with a transitory dummy (0, −1, 1, 1, 1, 0) for April 2020 (−1) and (+1) for May 2020 to August 2020;
- Croatian precipitation is near I(1);
- Slovenian precipitation is near I(1);
- Croatian earthquakes variable is seasonally adjusted and has a logarithm;
- Slovenian earthquakes variable has a logarithm;
- Croatian cloud cover variable is near I(1);
- Slovenian cloud cover variable is near I(1);
- The carbon dioxide variable has a logarithm.

The VAR analysis, presented in Equation (7), assumes the following information. First, tourism demand in Croatia is significantly negatively affected by carbon dioxide (the coefficient value is −16.606) and cloudiness (the coefficient value is −0.005) in the first lagged term. On the other hand, in the second lagged term, where the lags VAR (2) were chosen based on the Schwartz Criterion, the results adjust the threat of carbon dioxide, while the effect is positive due to the coefficient value of 17.011. Moreover, cloudiness in Slovenia additionally changes tourist demand in Croatia by a weight of −0.007. Overall, Croatian tourism could extend the season through strategic decisions on carbon dioxide specifications, while all other factors are statistically insignificant.

$$
\begin{bmatrix} \mathrm{lnARR\_HR}_t \\ \Delta\mathrm{ARR\_SI}_t \\ \mathrm{lnCO2\_HUN}_t \\ \mathrm{lnStQUA\_HR}_t \\ \mathrm{lnQUA\_SI}_t \\ \Delta\mathrm{RAI\_HR}_t \\ \Delta\mathrm{RAI\_SI}_t \\ \Delta\mathrm{SUN\_HR}_t \\ \Delta\mathrm{SUN\_SI}_t \end{bmatrix} = \begin{bmatrix} 0.86 & 0.00 & -16.61 & -0.02 & -0.01 & 0.00 & 0.00 & -0.01 & -0.00 \\ 30.91 & 0.08 & -1011.7 & -2.12 & -3.62 & 1.02 & -0.54 & -0.94 & 0.84 \\ -0.00 & -0.00 & 1.24 & 0.00 & -0.00 & -0.00 & 0.00 & 0.00 & -0.00 \\ 0.12 & 0.08 & -11.9 & 0.27 & -0.01 & 0.00 & -0.00 & 0.01 & -0.02 \\ -0.16 & 0.00 & -2.13 & 0.00 & 0.49 & 0.00 & 0.00 & -0.00 & -0.01 \\ 13.84 & -0.02 & -159.1 & 0.93 & -0.77 & -0.81 & 0.01 & 0.33 & -0.01 \\ 21.84 & -0.02 & -539.9 & 1.17 & 0.06 & -0.18 & -0.63 & 0.31 & 0.02 \\ -7.37 & -0.02 & 93.64 & 1.24 & -0.86 & -0.24 & 0.05 & -0.33 & 0.14 \\ 0.04 & -0.02 & 207.5 & 0.88 & 0.49 & -0.10 & 0.01 & 0.11 & -0.59 \end{bmatrix} \begin{bmatrix} \mathrm{lnARR\_HR}_{t-1} \\ \Delta\mathrm{ARR\_SI}_{t-1} \\ \mathrm{lnCO2\_HUN}_{t-1} \\ \mathrm{lnStQUA\_HR}_{t-1} \\ \mathrm{lnQUA\_SI}_{t-1} \\ \Delta\mathrm{RAI\_HR}_{t-1} \\ \Delta\mathrm{RAI\_SI}_{t-1} \\ \Delta\mathrm{SUN\_HR}_{t-1} \\ \Delta\mathrm{SUN\_SI}_{t-1} \end{bmatrix}
$$
$$
+ \begin{bmatrix} -0.16 & -0.00 & 17.01 & -0.02 & -0.01 & 0.00 & 0.00 & -0.00 & -0.01 \\ -50.6 & -0.17 & 1037.5 & -1.22 & 2.74 & 0.24 & 0.02 & -0.03 & -0.07 \\ 0.01 & 0.00 & -0.25 & -0.00 & 0.00 & -0.00 & 0.00 & 0.00 & -0.00 \\ -0.04 & -0.00 & 11.8 & 0.19 & 0.00 & 0.01 & -0.00 & -0.00 & 0.01 \\ 0.10 & -0.00 & 2.23 & 0.03 & 0.42 & -0.00 & 0.00 & -0.00 & -0.00 \\ -5.73 & -0.02 & 148.1 & -2.08 & 1.15 & -0.50 & 0.05 & 0.20 & -0.19 \\ -13.85 & -0.01 & 529.1 & -2.19 & 0.32 & -0.12 & -0.30 & 0.08 & -0.14 \\ 11.1 & -0.02 & -96.8 & -1.40 & 1.01 & -0.22 & 0.04 & -0.11 & 0.08 \\ 6.70 & -0.04 & -216.5 & -1.20 & -0.08 & -0.06 & 0.02 & -0.02 & -0.28 \end{bmatrix} \begin{bmatrix} \mathrm{lnARR\_HR}_{t-2} \\ \Delta\mathrm{ARR\_SI}_{t-2} \\ \mathrm{lnCO2\_HUN}_{t-2} \\ \mathrm{lnStQUA\_HR}_{t-2} \\ \mathrm{lnQUA\_SI}_{t-2} \\ \Delta\mathrm{RAI\_HR}_{t-2} \\ \Delta\mathrm{RAI\_SI}_{t-2} \\ \Delta\mathrm{SUN\_HR}_{t-2} \\ \Delta\mathrm{SUN\_SI}_{t-2} \end{bmatrix}
$$
$$
+ \begin{bmatrix} -1.06 & 1.58 \\ 13.44 & 95.38 \\ -0.01 & 0.01 \\ 1.65 & 0.11 \\ -0.77 & -0.05 \\ 52.47 & 24.23 \\ 79.19 & 31.81 \\ -12.11 & 21.81 \\ 4.45 & 23.86 \end{bmatrix} \begin{bmatrix} \mathrm{D}_{\mathrm{tr,t}\ \mathrm{HR}} \\ \mathrm{D}_{\mathrm{tr,t}\ \mathrm{SI}} \end{bmatrix} + \begin{bmatrix} u_{1\,t} \\ u_{2\,t} \\ u_{3\,t} \\ u_{4\,t} \\ u_{5\,t} \\ u_{6\,t} \\ u_{7\,t} \\ u_{8\,t} \\ u_{9\,t} \end{bmatrix} \quad (7)
$$

Second, tourist arrivals in Slovenia are positively associated with tourism demand in Croatia (the coefficient value is 30.907), rain in Croatia (the coefficient value is 1.020) and negatively associated with rainfall in Slovenia (the coefficient value is −0.538) and cloudiness in Croatia (the coefficient value is −0.939). On the other hand, the second lagged term establishes a significant decrease in tourist arrivals when tourist demand changes in Croatia (the coefficient value is −50.635), and demand decreases in terms of carbon dioxide, while the sum of the first and second lags is zero. In principle, Slovenia could rely on higher tourist demand during the rainy season in Croatia, but surprisingly also when the sun shines longer in Croatia. Both results could be used as a promotional tool, while the opening of the Schengen border will ensure a significant drop in tourist demand in Slovenia. In general, both countries tend to work on a carbon strategy, leading to higher demand in the long run.

Finally, the results of the VAR model (Figure 7) supported by the econometric model in (8)

$$
\Delta x_t = \Gamma_1\, \Delta x_{(t-1)} + \alpha\beta^{\sim\prime}\, x_{(t-1)} - \phi_{(tr.1)}\, D_{tr,\,t,\,SI}\ \mathrm{Y21M04}_t + \phi_{(tr.1)}\, D_{tr,\,t,\,SI}\ \mathrm{Y21M05\_08}_t - \phi_{(tr.2)}\, D_{tr,\,t,\,HR}\ \mathrm{Y21M04}_t + \phi_{(tr.2)}\, D_{tr,\,t,\,HR}\ \mathrm{Y21M05}_t + \gamma_0 + \varepsilon_t, \quad (8)
$$

predict an increase in tourist arrivals for both countries. At the same time, the forecasted decrease will be dramatic. The abbreviations in (8) are as follows: Y is the year, M is the month, tr is the transitory variable, ϕ is deterministic linear occasion, D is the dummy variable, Γ is the VAR matrix and $\alpha\beta^{\sim\prime}$ is an unrestricted data vector.

Note that the impact of microbes is not directly measured in this forecast. The effect of viruses is studied in Section 3.4.

3.3. Results of Cointegration

The choice of cointegration rank is likely to affect all subsequent conclusions and is, therefore, a crucial step in the empirical analysis. Unfortunately, the decision between stationary and nonstationary directions of the vector process is also often anything but straightforward. The formal test is based on the zero cases of the unit root, which is not always reasonable from an economic point of view. The LR test for cointegration rank, often called the trace test or Johansen test, is based on the VAR model in R-form, with all the short-run dynamics, dummies, and other deterministic components factored out. We estimated the model for r = 1, 2, 3, . . . , 9. For r = 7, a trace test statistic is found where the *p*-value is 0.003, and for r = 6, the *p*-value is 0.000. In contrast, for r = 8, the trace test *p*-value is 0.418 (Table 5).

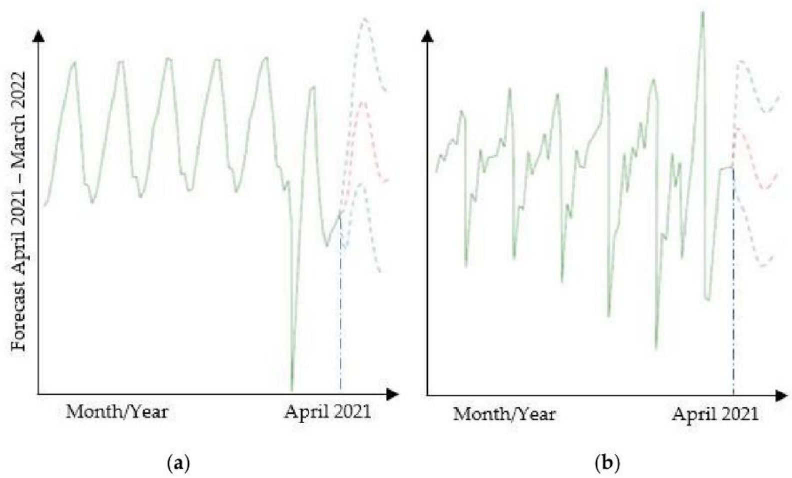


Figure 7. The VAR forecast for ARR: (**a**) Croatia; (**b**) Slovenia, from April 2021 to March 2022. Note: Source: authors calculations.

Table 5. Cointegration rank.

p-r	r	Trace	*p*-Value
9	0	1391.25	0.000
8	1	1118.41	0.000
7	2	871.58	0.000
6	3	647.72	0.000
5	4	440.02	0.000
4	5	265.62	0.000
3	6	115.26	0.000
2	7	57.19	0.000
1	8	18.74	0.004

Source: Authors calculations.

In the first case, an unrestricted constant term is included in the error correction (ECM) model. Since the constant term is unrestricted, it produces both a deterministic linear trend in the levels of the variables (through the gamma part) and a non-zero mean in the cointegration relations, but no linear trend in the cointegration relations, since the linear trends in the levels are cancelled. In the second case, the constant term is restricted to the cointegration relations. Thus, there are no trends in the levels, but non-zero averages are in the cointegration relations. We impose the constraint on the model that the rank of PI be r, which means that the nine variables in the model have r cointegration relationships and p-r common stochastic trends. In total, by introducing two transitory dummy variables into the model, there are eventually eight cointegration relationships and one common stochastic trend.

The stationarity of the variables was tested again. The most volatile variable is Slovenian ARR, but the variable remains in the model, since it is the regressed variable. In addition, variable i is stationary around a constant mean with a transitory shift; one of the cointegration relationships must be given by a linear combination of variable i, the constant term, and the level shift. When testing for the stationarity of variable i, we restrict one of the cointegration relations to the variable i, the constant term, and the level shift, while leaving the other cointegration relations unrestricted. Therefore, the hypothesis test (a sustainable human management of climate and ecosystems would significantly increase tourist arrivals in Croatia and Slovenia, which would reduce seasonal volatilities) in (9)

$$\beta_1 \, C^{\hat{}*} \, x_t = ARR_t + RAI_t + QUA_t + SUN_t + CO_{2t}, \tag{9}$$

allows the two spatial cointegration relations. The vector ECM (VECM) for Croatia in (10),

$$ARR_{HR,t} = 0.001 \, ARR_{SI,t-2} + 0.009 \, SUN_{SI\,t-1} - 0.003 \, SUN_{HR,t-2}, \tag{10}$$

allows for two explanations with statistically significant coefficients. For Croatia, the sun plays an important role. It is evident that every negative change in the mean value of cloud cover in Croatia produces an increase of 0.003 in tourist arrivals. Supporting this, every positive change in cloud cover in Slovenia creates a buoyant tourism demand in Croatia. Moreover, Croatian tourism benefits when Slovenia has a greater tourist demand. A second lagged effect confirms the results. However, for Slovenia, the VECM in (11)

$$ARR_{SI\,t} = 65.14 \, ARR_{HR,t-1} - 1.816 \, RAI_{HR,t-1} - 1.452 \, SUN_{SI,t-1} + 50.85 \, ARR_{HR,t-2} - 0.983 \, RAI_{HR\,t-2} + 0.486 \, RAI_{SI\,t-2} - 1.515 \, CO_{2SI,t-2}, \tag{11}$$

reports a somewhat different result. Slovenian tourism benefits when Croatian tourism is expanded by a value of 65.614 and in the first effect (one lag). In contrast, Slovenian tourism loses when it rains in Croatia and benefits when the average cloud cover declines. With a lag (second lag), Slovenian tourism benefits when Croatian tourism increases and loses when it rains in Croatia. On the other hand, demand for Slovenian tourism decreases due to carbon dioxide emissions. Surprisingly, rain in Slovenia significantly increases tourism demand in Slovenia.

In summary, supported by cointegration relationships and VECM, dark tourism associated with earthquakes is not an issue for the countries studied, as earthquakes do not significantly affect tourist arrivals. Second, Slovenian tourism benefits when Croatian tourism increases. Additionally, Slovenian tourism rises during the rainy season. On the other hand, the decrease in Croatia's rainy season is apparent (probably an effect of demand) and carbon emissions. Croatian tourism increases with fewer clouds in Slovenia, and there is a higher demand for Slovenian tourism. Overall, it can be concluded that both countries depend on tourism growth; therefore, spatial strategies should be implemented by policy-makers.

3.4. Results of the Sensitive Analysis—Pre-Pandemic Effect on a Panel

In the last part of the analysis, the microbes of great interest from 2019 are analysed. According to the ex ante research, two microbes affecting tourist arrivals were isolated by ECDC, namely *Salmonella* and *Campylobacter* (for Croatia and Slovenia) and viruses (for Slovenia). Consequently, the panel regression was estimated to obtain the robustness of the results based on a sensitivity analysis. All the variables studied in this research are included for a data vector and a defined period, as in 3. It is essential to define the sensitivity analysis to determine whether the previous methodology provides a robust result. At the same time, as suggested, due to significant volatility (see Figure 6), the variable, e.g., ARR in Slovenia, could be excluded from the analysis. Therefore, the decision is to implement microbes that generate the final shock in tourist arrivals and panels to obtain a sufficient degree of freedom while shortening the data vector in terms of a scarce disease data source. Overall, the sensitivity analysis checking the ordinary least squares parameters for a beta coefficient suggests a linear approach to fit the method's robustness [135]. In summary, the sensitivity analysis would characterise the first-class definition of the input variables in this study, i.e., the variables are sufficient to define a robust econometric model that recognises all possible obstacles and proposes a trait prediction [136].

The results of the sensitive analysis confirm the previous model strategy issues and results of the cointegration and the VAR model. The panel model with more than 10% significant coefficients for Croatia, when microbes are included, is (12):

$$\mathrm{ARR_{HR}} = 8.35\ \mathrm{ARR_{SI}} + 4.54\ \mathrm{RAI_{HR}} - 106.06\ \mathrm{CO2_{HR}} - 6.51\ \mathrm{SUN_{HR}}\ 3.91 + \mathrm{CAMP_{SI}} - 3.13\ \mathrm{CAM_{HR}}, \tag{12}$$

where CAM is *Campylobacter*.

The panel data model for Slovenia, when microbes are included, is (13):

$$\mathrm{ARR_{SI\,t}} = 0.09\ \mathrm{ARR_{HR}} + 8.97\ \mathrm{CO2_{HR}} + 0.50\ \mathrm{CAM_{HR}} - 0.48\ \mathrm{CAM_{SI}} + 0.08\ \mathrm{SAL_{HR}} - 0.10\ \mathrm{SAL_{SI}} - 0.18\ \mathrm{VIR_{SI}}, \tag{13}$$

where SAL is *Salmonella*.

Based on the panel model results, the conclusion is three-dimensional. Firstly, the countries are interdependent and should cooperate. Therefore, the opening of the Schengen border could bring Croatia an even higher tourism demand. Secondly, Croatian tourism depends on the weather conditions. In contrast to the VAR model, rain also causes more demand in the panel model. On the other hand, Slovenia suffers from microbes, while only in Slovenia are viruses a factor that significantly determines tourism demand. Thirdly, both countries should keep carbon dioxide in mind, while this method has statistically significant recognised CO_2 as an important factor that causes tourist arrivals.

4. Discussion

For the first time in the tourism literature, essential variables are brought together in one study and presented. The authors found no comparative research explaining ecosystem and environmental variables in the applied econometric approach, supported by sentiment analysis, for tourism worldwide. Moreover, there is not just a research specifically for the two EU countries, in this case, Croatia and Slovenia. The relevance of the analysed variables is discussed and supported by previous research. Therefore, the main contribution of this paper is twofold—a significant scientific impact as well as a practical impact on tourism destination management.

Nevertheless, the extended development of methodology in tourism is marked. The article's idea was to discover ways to reduce the seasonality volatilities; on the other hand, the notion is widely discussed for both countries in the scientific literature and the industry. In addition, the present research examines the impact on tourist arrivals of several—let us use the term—external factors. We learned that there are no external factors, only determinants that affect tourist arrivals during the pandemic. The better the diagnosis or prediction set, the better the outcome after a devastating shock.

The objective (to evaluate at least 100 recent manuscripts) in goal one (to provide an overview of the empirical research) is achieved. It is worth mentioning that many manuscripts deal with the direct impact of tourism on the environment, while only a few deal with the opposite issue. More than 100 previous empirical results have been revised, and the main conclusion for both destinations suggests that several essential factors determine the lengthening of the seasons. Previous studies highlighted some critical findings. Firstly, cloudy days have a significant impact on higher tourist arrivals instead of sunny days. Secondly, dark tourism based on earthquakes provides a considerable increase in tourist arrivals. Thirdly, green tourism with a low carbon footprint is the determinant that positively impacts tourist arrivals. Lastly, perhaps a little surprisingly but still significantly, the bacteria studied within the determinant microbes increase tourist demand.

On the other hand, precipitation has no significant effect on tourist demand; the only possible significance relates to the tourists visiting the chosen destination for the first time. Notably, viruses cause a significant decrease in tourism demand, highlighting coronaviruses and other viruses, so the threat of viruses will most likely continue.

Independently, the second goal has (due to growing general trends in the field of tourism sustainability) been reached, and the results are presented in Table 6. All other determinants have a minor impact. The cloudiness significantly reduces tourism demand in Croatia. In Slovenia, the top results confirm that rain in Croatia generates a higher demand in Slovenia; on the other hand, opening the border with Croatia would reduce demand in Slovenia. The empirical results of this study provide some new empirical findings that could have a significant impact on tourism theory.

Table 6. Sensitive analysis.

Regressor	Regressed	VAR		CVAR (ECM)		Panel (Sensitive)	
		National	Spatial	National	Spatial	National	Spatial
ARR	ARR_{HR}	/	✖	✖	✓(+)	✖	✓(+)
	ARR_{SI}	/	✓(−)	✖	✓(+)	✖	✓(+)
RAI	ARR_{HR}	✖	✖	✖	✖	✓(+)	✖
	ARR_{SI}	✓(−)	✓(+)	✓(+)	✓(−)	✖	✖
QUA	ARR_{HR}	✖	✖	✖	✖	✖	✖
	ARR_{SI}	✖	✖	✖	✖	✖	✖
SUN	ARR_{HR}	✓(+)	✓(+)	✓(+)	✓(+)	✓(+)	✖
	ARR_{SI}	✖	✓(+)	✓(+)	✓(+)	✖	✖
$MIC_{(VIR)}$	ARR_{HR}	/		/		✖	✖
	ARR_{SI}	/		/		✓(−)	✖
$MIC_{(BAC)}$	ARR_{HR}	/		/		✓(−)	✓(+)
	ARR_{SI}	/		/		✓(−)	✓(+)
CO_2	ARR_{HR}	✓(−)	✖	✖	/	✓(−)	✖
	ARR_{SI}	✓(−)	✖	✓(−)	/	✓(+)	✖

Note: ✓—statistically significant independent beta coefficient, ✖—statistically insignificant independent beta coefficient; S—spatial influence; /—not studied or defined parameter; (+, −) the direction of the causality is in brackets, where minus is negative and plus is a positive influence on ARR.

Contrary to previous empirical findings [137], earthquake-related dark tourism has no impact on tourism in Croatia and Slovenia. The chosen variable and supported results arise from the last literature on seismicity in Croatia and Slovenia, especially in the border region of Zagreb, Krsko and Brezice [138–141], followed by the recent earthquake in Zagreb in 2020. Second, sunshine has a positive influence on both countries, while previous studies found the opposite. Finally, rain has a positive effect on Slovenian tourism, while previous results show no significant impact. Overall, previous results and this study recommend that both countries revise their carbon strategies.

Together with the empirical results of this study and previous practical achievements, the development of this research is that Croatia and Slovenia could extend the tourism season and be increased by the following instruments:

1. Carbon dioxide strategy;
2. Supply of goods and attractions for cloudy days in Croatia;
3. Supply of goods and attractions for rainy days in Slovenia;
4. Sustain with the measures developed during the pandemic to avoid further spreading of bacillus;
5. Using econometrics and predictive analysis to determine and distribute solar days. Sunshine remains a necessary demand condition in both countries.

Nonetheless, sentiment analysis could be an additional tool for policy-makers to use the accompanying method of artificial intelligence to identify future impacts. A more efficient approach is to feed the Chatbot with Machine Learning Artificial Intelligence algorithms, such as NLP (Natural Language Processing). As an example for future research, the sentiment analysis tool has performed the concept of extraction for the website of the Croatian Tourism Authority. The evaluation value ranges from −10 to +10, where the weight around 0 is considered neutral. Figure 8 shows the detected concepts and related topics with the corresponding sentiment score.

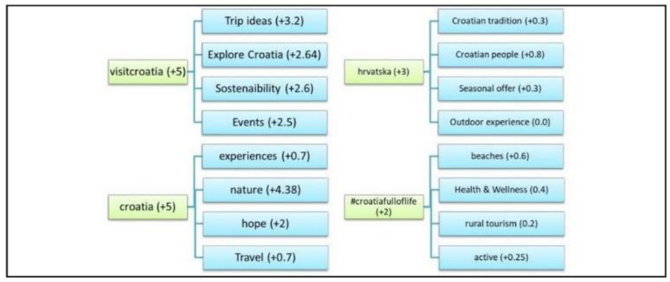


Figure 8. Sentiment evaluation for Croatian tourist board website.

The results shown in Figure 8 indicate that the general sentiment is neutral. Some positive moods related to words such as "nature", "hope", "events" ", sustainability", "trip ideas" and "explore", thus suggesting that a more balanced message should be given, also reinforce the other concepts related to tourism in Croatia.

The main limitation of the study is a limited number of independent variables. Still, due to the degrees of freedom, there is no possibility of extending this research. Researchers could add some other countries so that panel cointegration could be implemented [142,143]. Due to the significant volatility of several variables and the impossibility of achieving normalisation in the residuals, the panel cointegration is an essential formulation in the next study. Overall, it is not possible to construct a differentiated matrix of the cointegrated VAR model at this stage. At the same time, tourist arrivals in the short term are generally not normally distributed because of the Covid-19 event.

In summary, the VECM separated by a country could be a possible pre-panel solution to obtain meaningful results on the distributed variables. At the same time, there is no theoretical possibility, e.g., the theory does not provide answers to receive a correct distributional assumption on tourist arrivals in a period of significant decline due to the Covid-19 pandemic shock. The results show that not even integration or dummies could not solve the problem. Therefore, this study provides a first-rate outcome for a near-normally distributed asymptotic variable.

Nonetheless, the panel model in the sensitivity analysis, which includes microbes, highlights the importance of joint destination marketing and policy developments, and weather conditions play an even more significant positive role for Croatia. By contrast, microbes are a risk factor for Slovenian tourism.

Bottom line: leave the cars at home, travel by train, enjoy the rain, sun and green tours, and avoid microbes by washing hands. These are the factors that will increase tourism demand shortly and imperiously after the pandemic. The new normal could be a sustainable tourism strategy in the post-pandemic context. The at-a-glance results are presented in Table 6 to compare the different econometric methods used in the study that yield matching results.

The VAR model steadfastly confirms the carbon dioxide strategy. Second, the CVAR model demonstrates climate dependence and partial spatial climate dependence. Third, for Croatia, the panel ensures climate dependence (SUN, RAI), while for Slovenia, it confirms ecosystem dependence (MIC), which is also a spatially significant finding by ARR. At a glance, the results in Table 6 confirm the hypothesis that sustainable human management of climate and ecosystem would significantly increase tourism demand, where emissions are highly significant.

5. Conclusions

This pioneering research, accompanied with the selected secondary data, presented the sustainable factors influencing tourism demand and seasonality.

Based on the first goal, which is an overview of the empirical literature, the main conclusions are as follows.

1. Tourist demand is not a factual situation;
2. Quantitative analysis is essential for better planning and strategic dimensions in tourism;
3. Tourism thinking is moving towards sustainable tourism, e.g.:
    - Average temperatures should not rise above 31 degrees Celsius during the holidays;
    - Rain and cloud cover significantly affect tourism demand;
    - CO_2 emissions play an essential role for tourists;

The second goal (to highlight the growing general trends in the field of sustainability) with three objectives confirms the hypothesis that seasonality matters in tourism. Still, the results show that strategic and sustainable thinking could reduce the overwhelming demand during the summer months and reduce supply problems in the low season. In conclusion, spatial dimensions matter, so policymakers in Croatia and Slovenia need to do a thorough and coordinated job. Sustainable tourism strategies in a pandemic context are essential. Therefore, our added value to the theory is twofold—first, the use of an appropriate quantitative methodology with applied function rather than qualitative subjectification. Second, the environment and ecosystem regressors are affecting tourist arrivals. Therefore, the first objective (selection of variables) of the second goal proposes precipitation, cloud cover, earthquakes, microbes and green emissions as independent variables in a time series approach. The second objective searches for determinants of increase/decrease tourism demand in Croatia and Slovenia. It shows that the most critical determinant is CO_2. The determinant CO_2 represents a valuable strategic work for the future increase of tourism.

Moreover, the two countries depend on tourist arrivals, i.e., expected increases or decreases. In terms of tourism strategy, depending on the type of tourism, the sun is still an important issue, even more so for Croatia. At the same time, the weather conditions play a significant role for the next tourism generation, so the strategy should recognise their need and expectations. Split results of one country showed that Slovenia could gain from precipitation and lose from microbes. Therefore, Slovenian tourism should turn to these determinants and, we can say, trends that confirm the final objective (what weather conditions might influence this tourism trend) of the second goal.

Finally, the limitation of the study is that the quantitative research might be missing some essential variables. After that, additional research could improve the results. A further qualitative survey could provide insights into the mindset of tourists.

In summary, panel regression indicates that both countries have spatial benefits, i.e., greater demand. Separately, and conclusively to rivalry determinants, Croatian tourism is more likely sensitive to weather factors, i.e., less rain and clouds bring more tourists. By contrast, Slovenian tourism suffers from ecosystem determinants—with more microbes there are fewer tourists. Overall, carbon dioxide is an important strategic factor for both countries. In conclusion, the sentiment analysis has shown that more importance should be given to sustainability.

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9.5 ATTACHMENT 3.

The missing link between wages and labour productivity in tourism: evidence from Croatia and Slovenia

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The missing link between wages and labour productivity in tourism: evidence from Croatia and Slovenia

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ABSTRACT

The present article aims to analyse wage-labour productivity causalities in Croatia and Slovenia using cointegration methods based on monthly time series data of variables for labour productivity and real gross wages in tourism industry during the period December 1999–January 2020. The data vector is integrated by chain indices with the constant base January 2000 = 100. A stochastic trend and shocks are covered in the analysis. Shocks are linked to the European Union accession, and economic crisis following with overwhelmed tourist arrivals. The contribution of the research is two-fold. First, the equations for at most normal distributed variables of labour productivity and real wages in tourism are exposed. Three spatial cointegration relations confirm labour productivity integrity of the regional tourism market. Second, pair-wise causalities indicate one cointegrated vector for labour productivity, which drives real gross wages in tourism sub-industries. These results suggest that for a higher non-seasonal assessment of real gross wage, the labour productivity should rise, i.e. less workers, more robotization or more tourist arrivals with better quality solutions. These findings are at most important to be implemented after the COVID-19 infection crisis with expected restructurings and digital transformation in the tourism industry.

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Croatia; error correction model (ECM); real gross wage; labour productivity; Slovenia; vector error correction model (VECM)

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1. Introduction

Tourism is a key sector with its deterministic influences on national economies in almost all Adriatic countries. Therefore, tourism and service sectors should seek for a better understanding on macroeconomic relevant issues, for example on labour productivity and real gross wage, rather than zigzag microeconomic "hair in the egg" findings. In tourism, there is a specific need to understand that macroeconomic environment can have an important external influence on each company as seen in March 2020 hereafter. This applies not only for tourism, but on all spatial and

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borderless (export) services. Provenzano and Baggio (2019) proposed simple methodological step(s) in quantitative analysis of tourism and hospitality industry, while Juselius and Drehmann (2020) warn of data puzzles. For example, based on macroeconomic data Gričar (2019) predicts decline in tourism industry for the hot spot tourism destination, i.e. Slovenia (Warren, 2019). The decline in 2020s is predicted on a grade of 20% and is silenced to a prediction of UN World Tourism Organisation (2020).

Successful and efficient analysis of tourism, one of the leading economic sectors in exports and employment, requires specific and adequate quantitative methods in modelling and forecasting of the future trends and key market determinants. In this paper applied comparative analysis between Croatia and Slovenia is motivated by the lack of adequate empirical analyses in the field of tourism industry. The service economy represents more than 60% of total gross domestic product (GDP) in both Croatia and in Slovenia, respectively. Both countries are known by the increasing role of tourism in the national economy. In 2017, the Slovenian tourism contributed 5.3% of total GDP (SORS, 2020), whereas in Croatia, one of the leading tourist destinations, the tourism sector is even more important in the structure of the national economy as it counts 19.6% of total GDP (Gulić, 2018).

These two neighbouring countries shared a common history in 20th century and become independent from the Yugoslav federation in 1991. Both countries have made its own economic path and growth (Gričar et al., 2019). They are positioned at the Adriatic Sea and are members of the European Union (EU). Contrarily to Croatia, which is expected to enter into the European Exchange Rate Mechanism II, Slovenia adopted euro as a national currency in 2007 as a first post-socialistic country. In 2018, Croatia attracted 16.6 million of international tourist arrivals, while Slovenia had 4.4 million of international tourist arrivals (World Bank, 2020). The article closes the gap in literature regarding comparisons of real gross wage and labour productivity in tourism industry in Croatia and Slovenia. More specifically, the paper aims to answer whether there are similarities and differences between the two countries in tourism labour productivity and real gross wage. To do so, we conduct cointegration tests on time series data for labour productivity and real gross wage in the tourism sub-industry (accommodation and food and beverage services). The first aim is to analyse previous empirical researches on the causalities between real gross wage and labour productivity. The second aim is to develop empirical models for Croatia and Slovenia on real gross wage and labour productivity using secondary time series data.

The next section provides brief literature review. In the third section the data vector and methodology are explicated. Empirical results are presented in the fourth section followed by the discussion in the fifth section. Contemporary research is concluded by implications, restrictions and conclusion sections.

2. Literature review

Gričar and Bojnec (2019) recognised that the perception of the security of stable prices for customers could play more important role than prices alone, because it implies that price stability determines hotel competitiveness. Gross wage could be an important element of the price, as well as for causality between gross wage and labour productivity. The problem of how to ensure the growth of labour productivity in tourism is especially relevant in developing economies (Dua & Garg, 2019; Silva & Guimarães, 2017; Stundziene & Saboniene, 2019).

There are rare studies concerning spatial labour market activities in neighbouring Central European countries (CEC). While labour productivity has been widely studied for manufacturing activities, this has been largely neglected for service activities, including for the tourism sector (Sunanda & Dinabandhu, 2019; Yildirim, 2015). Such studies can contribute to better understanding the drivers of gross wage formation and links between gross wage and labour productivity (Assaf & Tsionas, 2018; Chatzimichael & Liasidou, 2019; Kim & Jang, 2019; Liu & Wu, 2019; Pham, 2020; Walmsley et al., 2019).

Even scarcer are studies concerning Croatia and Slovenia regarding causalities between real gross wage and labour productivity in tourism industry. In the past, Weinschenck (1979) found development problems of labour-managed market economies with 'mixed' structures consisting of large labour-managed firms. There is only one study on tourism productivity in two neighbouring Adriatic countries using panel data (Tkalec & Vizek, 2016), but not for applied unit root tests in a time series. Ilić and Petrevska (2018) discuss statistical methods for measuring efficiency in the Slovenian and Croatian tourism sector, whereas Žigo et al. (2017) discuss questions on immigrant workers in Slovenia using interviews as a method.

The results in previous studies confirmed some similarity in patterns of development of wages and labour productivity levels. Bojnec (2003) argued that wages in Slovenia were higher than in other transition post-communist countries and higher than labour productivity. Labour productivity and competitive pressures in firms' output markets were not found important for wage formation. Moreover, Bojnec (2004) reported that the increase in labour productivity only partly explains real wage increases in Slovenia, suggesting an important role of other, unexplained factors in wage formation.

Kump and Novokmet (2018) analyse income inequality in Croatia and Slovenia based on long term time series, not only from Yugoslav long history (1918–1991), but also from the earlier period from 1898 to 1918 within the Austro-Hungarian Monarchy. They argue that substantial importance of the state ownership of the corporate sector in Slovenia and foreign and state ownership in Croatia have made the concentration of private capital income less pronounced on the top of the income distribution. They show new inequality series for Croatia and Slovenia as a contribution to assessing the importance of policies and institutions in shaping inequality. The ownership structures emerging from the various privatization programmes in Slovenia have not led to a higher performance of growing sustainability (Lahovnik, 2019).

Kotarski and Petak (2019) claim that the political economy of Croatia's transition represents the case of partial reform equilibrium where winners represent the biggest threat to successful long-term transition. In addition, comparative political economy analysis of five key areas (product market competition, collective bargaining, financial sector, social protection and education) shows that Croatia developed a typical variation of capitalism, which is in its attributes closer to South European capitalisms than to capitalisms prevalent in CEC EU member states.

Grulja et al. (2013) show that Croatia and Slovenia differ not only in level of average gross wage, but also in the overall taxation of wages. In 2018 Slovenia recorded 87% of the EU average GDP per capita in purchasing power standards (PPS), while in Croatia it was only 63% (Eurostat, 2020). Those countries are also part of the Alps-Adriatic working community and the difference in this region on gross wages are considerable. In 2010 the average gross wage in Slovenia was slightly more taxed than in Croatia: the overall tax wedge in former represented around 42% of labour costs and 40.6% in the latter (Grulja et al., 2013).

The Croatian and Slovenian economies have faced complex and interrelated political and economic problems with delays in improvements of labour market conditions. Gligorov et al. (2008) argued that lower rise in GDP in the Western Balkan is not transmitted to causality between wage and labour productivity. The main reasons are structural: low export capacity, skill mismatches, and problems with competition in the product markets. Except for wages in the public sector, wages were not found to grow faster than labour productivity.

Kersan-Škabić (2015) conducted research on macroeconomic data using panel method including labour productivity for new EU member states. It was recognised that in the pre-crisis period labour costs rose faster than labour productivity, while that was not the case in the EU-28 average. In the period 2010–2014 most of the countries experienced growth rates of labour productivity, but significantly slower than in the pre-crisis period.

The Adriatic region, where both countries belong, has a substantial deficit of scientific research. One of the reasons is shortcoming of the available secondary data in a long term. Table 1 summarises the previous empirical researches on labour productivity and wages in general and especially in the tourism sector.

The size of the informal sector activities, irrespective of the method used indicates a considerable share of the unofficial or shadow economy (Nastav & Bojnec, 2007). Arandarenko and Vukojevic (2008) stated that formality and informality do not appear as binary choice, but rather along a spectrum of statuses, from full informality through semi-formality (tourism industry with sharing services, self-employment, double payrolls in many small private firms), to full formality most typically in the public sector. The availability of secondary data can represent limitations for research (Badshah & Bulut, 2020; Dogru & Bulut, 2018; Gulić, 2018; Hall, 2002; Yalçinkaya et al., 2018). Finally, quality in tourism services cannot be measured merely by the number of stars, or by investment in infrastructure. The highest contribution to the quality or deficiency of any service in tourism relates to the employees (Zanini Gavranić & Šugar, 2019). Therefore, labour productivity and wages are of highest importance for the overall quality of service in tourism sub-industries. The overall quality could be measured by income, output, loyalty and complain equations indicators. Following the previous literature, the hypothesis is defined as follows:

Table 1. Overview of recent previous empirical researches on wage-labour productivity.

Author(s)	Method(s)	Main conclusion / determinant
Productivity in tradable and non-tradable sectors		
Veselinović et al. (2020)	Ordinary least squares	Gross wages rise when education of employee match employer's expectations
Lin and Weng (2019)	Equilibrium model of comparative analysis	Two markets have critical points of choosing export and demanding productivity
Stundziene and Saboniene (2019)	Granger Causality, vector autoregressive (VAR) model	Investment in tangible goods provides rise in productivity
Yian (2019)	Panel analysis	Avoiding labour mismatch could increase labour productivity by 41%
Gabrielczak and Serwach (2018)	Olley–Pakes algorithm	Firms in particular region do not gain productivity regarding international trade or investment
Jaržemskis and Jaržemskienė (2018)	Data envelopment analysis	The productivity for selected airports on a set of factors was not confirmed
Noja (2018)	Clusters – standardisation method	Analysing productivity in EU Member States in Central and Eastern Europe on flexicurity
Uruena et al. (2018)	Qualitative Comparative Analysis	Software development od Android system to productivity measurements for workers
Baležentis and Baležentis (2016)	Bootstrapped Malmquist productivity index	The productivity in farming has decreased
Škuflić and Družić (2016)	Static panel analysis	Higher level of market dynamics in deindustrialisation increases productivity
Yildirim (2015)	Granger causality test	Productivity, wages and inflation are analysed
Dragos et al. (2014)	Ordinary least squares	The bibliometric analysis reflects on productivity in renovated journals
Productivity in tourism industry		
Dimitriou and Aparicio (2018)	Multi-objective unweighted analysis	Productivity effect is on mobile, connectivity and region attractiveness costs
Mody et al. (2018)	Case study	Productivity based on the researches in tourism and hospitality industry management
Zuo and Li (2018)	Sequential data envelope analysis	Allocation is a factor to tourism quality and productivity
Li (2014)	Feasible generalized least squares	Human capital and knowledge do support productivity in tourism and hospitality industry. The case of Canada
Peypoch (2007)	Luenberger productivity indicator	French tourism sub-industry sector of beds is analysed

Source: authors.

The null hypothesis H_0: there is no-causal-cointegrated relationship between labour productivity and real gross wage.

The alternative hypothesis H_1: there is uni-directional-causal-cointegrated relationship between real gross wage and labour productivity in the tourism sector in Slovenia and Croatia. The tested model is expressed in Equation (8), i.e., productivity precipitates wages. This main empirical model follows the salient theoretical model presented in Equation (7) appearance of data vector which is dispensed in Equation (10).

3. Data and methodology

Tourism can be a key to economy growth (Fonseca & Sánchez-Rivero, 2020) in the most of the Adriatic countries. It seeks for new techniques that are more stable in its proficiency and prediction. Some analyses regarding ordinary least squares (OLS) in tourism are spurious.

While the time series approaches to unit root and stationarity testing appear very similar on the surface, in fact a valid construction and application of the test statistics is much more complex for time series than for single OLS series. A difficulty arises since different asymptotic distribution for the test statistics may result depending on whether the number of all observations (N) is fixed and T (as much time series data as possible) tends to infinity, or vice versa, or both T and N increase simultaneously in a fixed ration.

Hence, it would be easier to increase the number of observations by simply increasing the length of the sample period. However, this data may not be available. There is a reason more, because of structural breaks in the time series, e.g. seasons, policy maker decisions, economic crisis, adverse weather conditions and other unexpected events.

3.1. Data

Time series data of four variables are obtained from the national statistical offices; for Croatian data, the Croatian Bureau of Statistics (CBS, 2020), and for Slovenia, Statistical Office of Republic of Slovenia (SORS, 2020). December 1999 is a first period month, which links relatives of current month:

$$I_{n-1,\,n} = \frac{I_n}{I_{n-1}} \cdot 100, \tag{1}$$

where I_n is nominal value of current month, I_{n-1} is nominal value of previous month, and December 1999 is first observed month. Therefore, the chain index taking January 2000 = 100 as the base month is:

$$I_{0,\,t} = \frac{I_t \cdot I_{t-1}}{100}, \tag{2}$$

where I_t is the current month linked to relative, and I_{t-1} is the previous month linked to relative.

The following four variables have been used in the empirical analysis: i) gross wage (W), which is deflated by constant base harmonized, ii) consumer price index (CPI) to obtain real gross wage, and iii) tourist arrivals (ARR) divided by the iv) number of employees (EMPLOY) in the tourism sub-sector to obtain labour productivity.

The employees in crafts, trades, and freelancers are not included in the analyses. For the latter the main reason of such a decision is that Croatia provides data for this kind of employment only from 2010 onwards. Therefore, if we include total employment, we lose the pre-crisis and crisis periods. The analyses showed that employees in paid employments by legal persons represent most of the employees in both countries; in Croatia 64.4% and in Slovenia 63.7%, respectively. Therefore, in the paper the importance of degrees of freedom is respected.

3.2. Methodology

The data used in levels are presented in Figures 1 and 2 to become familiar with their time series properties and comparisons between the countries. In addition to check whether there are some similarities and differences in collected variables, it is also computed labour productivity (PROD) for Croatia and Slovenia. In Figure 1 there is a dispersion of time series for Slovenia and in Figure 2 for Croatia. Second, the calculated variables PROD and real W (W_t^r) in Equation (4) are presented in Figures 3–6.

Figures 1 and 2 indicate that in both countries CPI is relatively low and under control. ARR and W experienced seasonality in Slovenia whereas EMPLOY and CPI look more stable (Figure 1). In Croatia, ARR, W and EMPLOY experienced obvious seasonality (Figure 2). Therefore, the data are in a seasonal manner and a large part of the change in scale is determined by a seasonal pattern that is parsimoniously modelled by cubic spline. Harvey and Ito (2020) report seasonal pattern in time series assumed to be fixed.

The volatility of all variables except for CPI is high and therefore we can estimate with no normal and no stable model if variables in levels are included in the finite model. Therefore, variables have been transformed into the real ones; computed as expressed by Equations (3) (4) and (5) to obtain distributed residuals for the equations that provide real gross wage and labour productivity for both countries in a reliable empirical model.

For a credible result, we employ Equation (3) relative of gross wage to CPI:

$$W_t^r = \frac{W_t^{HR,SI}}{CPI_{t-1}^{HR,SI}}, \tag{3}$$

where CPI measures inflation (Gričar & Bojnec, 2019). For the exact analysis equations of the labour productivity in tourism industry are performed, where labour productivity is analysed as output measured by ARR divided by EMPLOY in the tourism sub-industry (3). In the case of this research, the number of tourist arrivals are divided by the number of employees in tourism industry for Croatia and Slovenia (4). The equations are listed in a form:

$$PROD = \frac{OUTPUT}{EMPLOYMENT}, \tag{4}$$

$$PROD_t = \frac{ARR_t^{HR,\ SI}}{EMPLOY_t^{HR,\ SI}}, \tag{5}$$

where abbreviations used are: HR for Croatia, SI for Slovenia, t for time series.

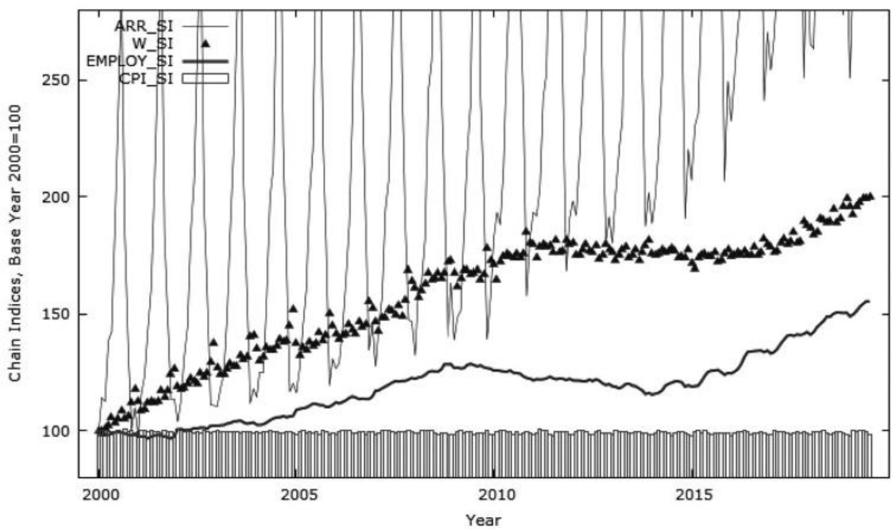

Figure 1. Dispersion of time series in levels for Slovenia.
Notes: ARR_SI – Number of tourist arrivals in Slovenia, W_SI – Gross wage in tourism sub-industries in Slovenia, EMPLOY_SI – Number of employees in tourism sub-industries in Slovenia, CPI_SI – Harmonized consumer price index for Slovenia.
Source: SORS (2020).

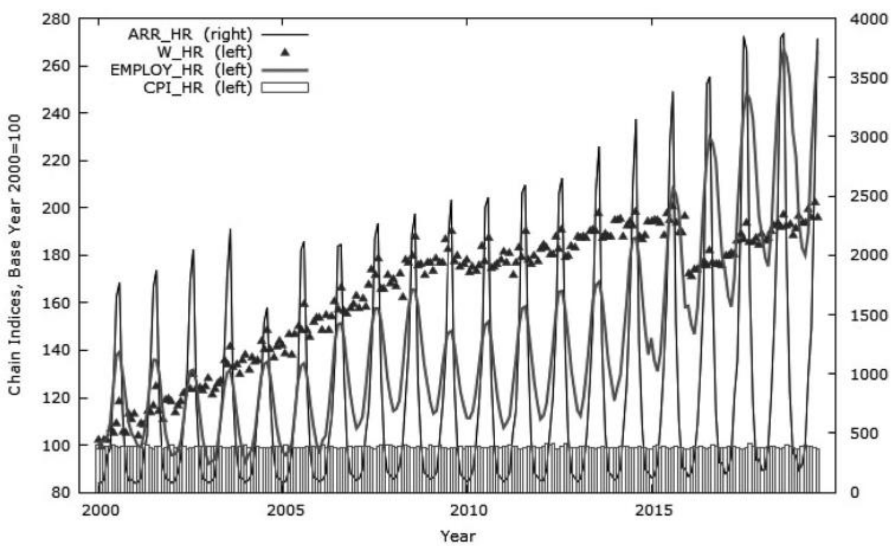

Figure 2. Dispersion of time series in levels for Croatia.
Notes: ARR_HR – Number of tourist arrivals in Croatia, W_HR – Gross wage in tourism sub-industries in Croatia, EMPLOY_HR – Number of employees in tourism sub-industries in Croatia, CPI_HR – Harmonized consumer price index for Croatia.
Source: CBS (2020).

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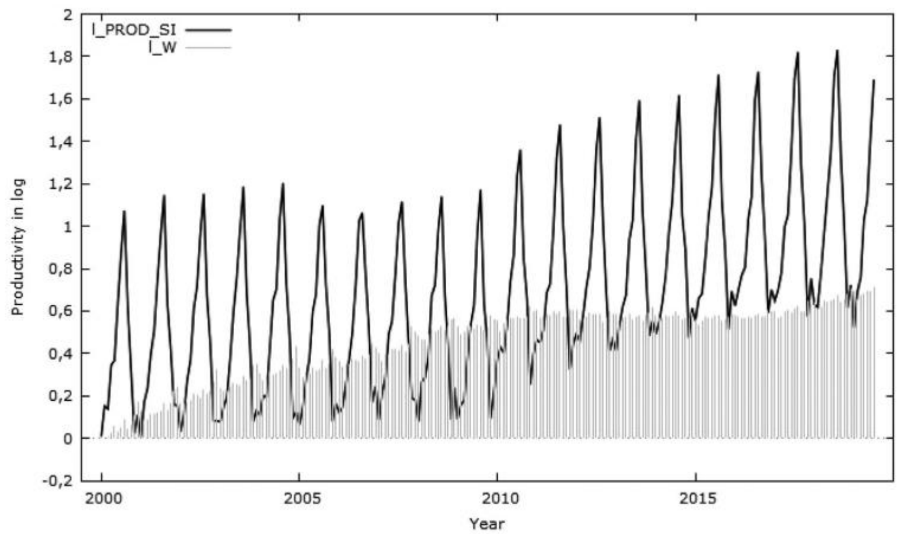

Figure 3. Dispersion of labour productivity and real gross wage in logs for Slovenia.
Notes: l_PROD_SI – logarithm of labour productivity for Slovenia, l_W – real gross wage for Slovenia.
Source: SORS (2020); authors.

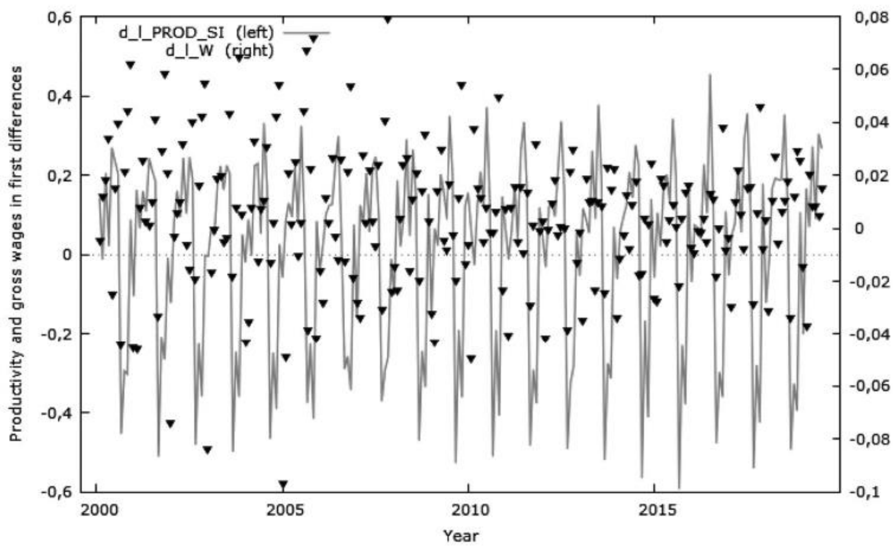

Figure 4. Dispersion of labour productivity and real gross wage in the first differences for Slovenia.
Notes: d – first differences in time series.
Source: SORS (2020); authors.

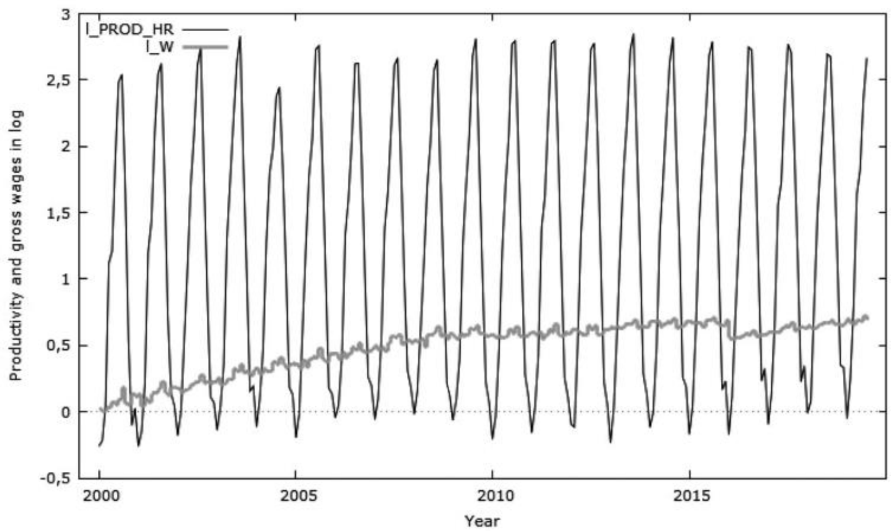

Figure 5. Dispersion of labour productivity and real gross wage in logs for Croatia.
Note: l_PROD_HR – logarithm of labour productivity for Croatia, l_W – real gross wage for Croatia.
Source: CBS (2020); authors.

Finally, the cointegration is foreseen:

$$y_t = \beta_1 + \beta_2 \cdot x_{2t} + u_t, \tag{6}$$

where y_t is dependent variable, x_{2t} is independent variable, β long-term coefficient, and u_t are residuals; adjustment coefficient. Some authors discussed about the cointegration, e.g. Brooks (2019). There are several possible steps to get generalisation on cointegration in the literature such as for example Tang (2010, 2012, 2014).

Testing for cointegration using the residuals following these extensions of Engle and Granger (Brooks, 2019) is also possible, although in general more complicated than to use a generalisation of the Johansen technique by Tang (2010). This approach is simple alternative for each group of series separately, collecting the p-values for the trace test and then take two times the sum of their logs. A fully approach based on a vector autoregressive model (VAR) model:

$$x_t = \mu_o + \Pi_1 \cdot x_{t+1} + \ldots + \Pi_k \cdot x_{k+1} + \varepsilon_t; t = 1, \ldots T, \tag{7}$$

where ε_t is i.i.d. $(0, \Omega)$ and $x_0, \ldots x_{-k+1}$ are assumed fixed. Thus, even when the observations x_t are strongly time dependent, the conditional process $(x_t|X^0_{t-1})$ is independent and OLS estimates of $\{\Pi_1, \ldots \Pi_k, \ \mu_o, \Omega\}$ are Maximum Likelihood estimates; and error correction model (ECM):

$$\Delta y_t = \beta_1 \cdot \Delta x_t + \beta_2 \cdot (y_{t-1} - \gamma \cdot x_{t-1}) + u_t, \tag{8}$$

are possible but with considerable additional complexity.

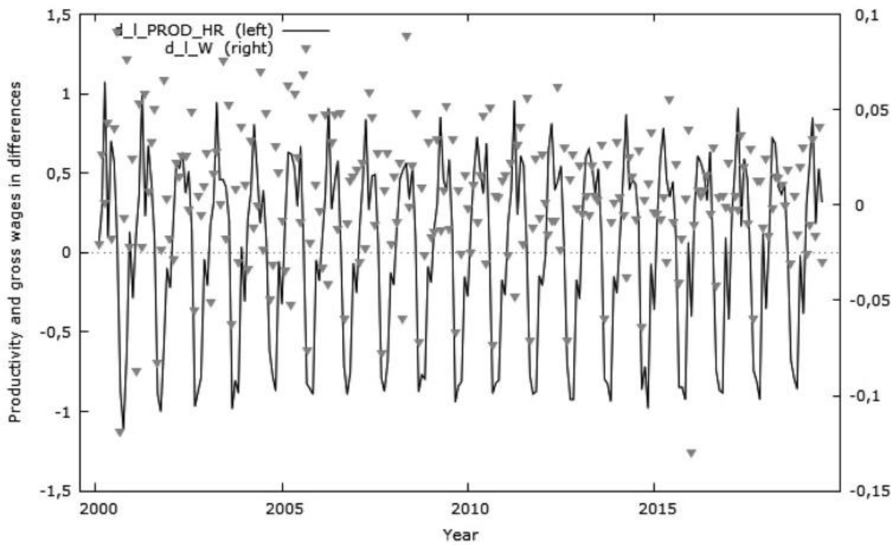

Figure 6. Dispersion of labour productivity and real gross wage in the first differences for Croatia.
Notes: d – first differences in time series.
Source: CBS (2020); authors.

4. Empirical results

4.1. Empirical settings

In Tables 2 and 3 are presented three variables in levels. First, ARR as tourism industry output (Gholipour et al., 2020). Tourist is sustaining in a transformation process as a coherent output. Second, PROD in a wage-labour productivity manner requires two-time series variables to calculate labour productivity as a ratio between ARR and EMPLOY in the tourism sub-industry, which are obtained from the statistical sources; EMPLOY is the number of persons in paid employment in legal entities. The last variable is W in tourism sub-industry. The later was deflated by CPI. Therefore, the data vector analysed in this research is two-fold. First, the data vector of variables in levels $I(0)$:

$$ {}^{I(0)}_{T}[ARR\ \ EMPLOY\ \ W]_t^{i,\ j}\ {}^{ex}_{T}[CPI]_t^{i,\ j},\ \ t = 1, \ldots, 242, \tag{9} $$

where i and j are Slovenia and Croatia, respectively, *ex* is exogenous variable, t time series and T length of time series. Second, the data vector in differences:

$$ {}^{I(2)}_{T}[lnW^r lnPROD]_{t-1}^{i,\ j},\ \ t = 1, \ldots, T, \tag{10} $$

which are included in cointegration analysis, ECM and VAR model; and variables are at most $\sim I(2)$. Therefore, the empirical part includes data sets from Equation (9) presented in four steps: first, summary statistics and visual inspection; second, Granger Causality test; third, ECM; and fourth, VAR and VECM following theoretical

Table 2. Overview of monthly data and misspecification tests, Croatia, T = 242.

Time series Variable Name	Number of tourist arrivals ARR	Gross wage in tourism sub-industries W	Number of employees in tourism sub-industries Employ
Break: Min; Emerging economy	January 2000: *87,282* (77.28)	February 2000: *3,585.00 HRK*[a] (99.58)	January 2003: *33,060* (92.09)
Break: Max; Overwhelmed economy	August 2019: *4,712,039* (4171.90)	January 2020: *7,527.00 HRK* (209.08)	August 2019: *101,312* (282.21)
SD; Seasonal roots	*1,061,259.20* (939.61)	*1,020.00 HRK* (28.33)	*15,680.72* (43.68)
Mean; to achieve in low season (*goal*)	*965,283.72* (854.63)	*5,955.78 HRK* (165.44)	*52,623.94* (146.58)
ADF test	−0,06	−2,22*	−0,73
Real time series	ADF test	Lilliefors normality test	
W_t^r	1.50*	27.85***	
$PROD_t$	0.76	46.41***	
Differenced	$(PROD_t = 0.49 + 2.84^{***} \cdot W_t^r)^{***}$		
OLS			
lnW_{t-1}^r	−2.08** (constant)	19.61**	
$lnPROD_{t-1}$	−6,88*** (constant)	17,29***	

Note: *Nominal values in italics* and (chain indices, January 2000 = 100 in brackets), ADF – Augmented Dickey Fuller test; OLS –regression on cointegrated variables.
[a]Long term-exchange rate of a euro is equal to 7.4345 Croatian kuna (EUR 1 = HRK 7.4345) (ECB, 2020).
***1% significance.
**5% significance.
*10% significance.
Source: CBS (2020).

considerations (Brooks, 2019) and empirical approaches (Badshah & Bulut, 2020; Tang, 2010, 2012, 2014).

4.2. Summary statistics

Summary statistics of the collected secondary data for Croatia and Slovenia during the period December 1999–January 2020, i.e., for 242 observations, are presented in Tables 2 and 3, respectively.

In the case of Croatia (Table 2), a large maximum value in the number of tourist arrivals (ARR) is recognised. Its index is 4,171.90 for August 2019. This confirms rapid increases in ARR in Croatia to an overwhelmed nominal number of almost five million of tourist in a month; Croatia has a bit less than four million of inhabitants (Gričar et al., 2019). The result is scary having in mind of that public infrastructure, transportation and other facilities needs to be in a function for such a process output. Contrary, when lockdown due a sudden pandemic shock, it is a challenge for higher unemployment in tourism sector (Yu et al., 2020). The EMPLOY was the lowest in January 2003 and the highest in August 2019. On the other hand, W in Croatia was on the lowest level in February 2000 and the highest in January 2020 when a person earns 7.5 thousand Croatian kuna, which is a bit more than one thousand euro.

The data for Slovenia (Table 3) shows that ARR is the most volatile variable with its standard deviation of 159.04. W (210.00) rose faster than EMPLOY (155.47). The lowest index of EMPLOY is 97.89 for January 2000 and of W for February 2000 (99.83).

The misspecification tests of ADF and normality test (Lilliefors test) for the variables in levels (Equation 9), and relative variables (Equations 3 and 5) confirmed unit

Table 3. Overview of monthly data and misspecification tests, Slovenia, T = 242.

Time series Variable Name	Number of tourist arrivals ARR	Gross wage in tourism sub-industries W	Number of employees in tourism sub-industries Employ
Break: Min; Developing economy	January 2001: *103,629* (98.00)	February 2000: *612.94 euro* (99.83)	November 2001: *15,942* January 2000: (97.89)
Break: Max; Overwhelmed economy	August 2019: *1,067,416* (1,009.46)	November 2019: *1,289,37* *EUR* (210.00)	October 2019: *25,653* (155.47)
SD; Seasonal roots	*168,170.47* (159.04)	*161.94 EUR* (26.38)	*2,516,43* (15.25)
Mean; to achieve in low season (goal)	*286,754.33* (271.19)	*980.30 EUR* (159.66)	*19,823.40* (120.14)
ADF	−0.17	2.24	−2.89
Real time series	ADF test	Lilliefors normality test	
W_t^r	1.53	17.81***	
$PROD_t$	2.78	194.58***	
Differenced	$(PROD_t = -0.48 + 1.66^{***} \cdot W_t^r)^{***}$		
OLS			
lnW_{t-1}^r	−1.81**	15.03**	
$lnPROD_{t-1}$	−3.48***	26.23***	

Note: *Nominal values in italics* and (chain indices, January 2000 = 100 in brackets), ADF – Augmented Dickey Fuller test; OLS –regression on cointegrated variables.
***1% significance.
**5% significance.
Source: SORS (2020).

root and proposed cointegration between analysed variables. The appropriate strategy for econometric modelling in this case would be to form and estimate an ECM on three steps procedure. First, to obtain misspecification test for the stability of the process, second, to import cointegration regression (Equation 6) for a long-term, and third, to employ causality relationship using Granger Causality technique for a short-term. Additionally, Johansen cointegration in a VAR is foreseen. The VAR is a natural framework for analysing some types of nonstationary processes and cointegration turns out to be a natural concept to describe long-term relations in economics and other fields, i.e. tourism.

In the case, there are two differenced variables (Equations 3 and 5) in an Equation (6); say there can be at most only one linear cointegration of y_t and x_t that is stationary, i.e., at most one cointegrating relationship. The results of cointegration regression in Tables 2 and 3 show that there could be only one stationary relation for each spatial equation. The relation $PROD_t$ is dependent variable and W_t^r is independent variable. The speed of adjustment of $PROD_t$ in Croatia is at below mean level and therefore has upward trend of 0.49 in a long-term. The beta coefficient for Croatia confirms that increase in W_t^r of one produce better labour productivity of 2.84 in a long-term (Table 2). On the other hand, results for Slovenia indicate slower speed of adjustment on a level of 0.48 and has negative trend in a long-term. The beta coefficient for Slovenia confirms that increase in W_t^r of one produce better labour productivity of 1.66 in a long-term (Table 2).

4.3. Visual inspection for Slovenia

The comparison of Slovenian W and PROD in logs are plotted in Figure 3. It can be concluded that W after 2013 did not follow the PROD in tourism sub-industries (accommodation and food and beverage services).

On the other hand, variables are highly volatile and therefore additional calculation is needed. For more accurate further analysis, variables are transformed in the first differences (Figure 4, Table 2). From Figure 4 we can obtain that W^r_{t-1} after 2013 have some specifics in most volatile months. This could lead to the conclusion that managers in tourism industry and policy decisions managers need to find the way to prolonged season with more employment during the whole year. Better quality service during the entire year can contribute to a lower volatility. Among the most optimal years for tourists, tourism enterprises and employees in Slovenia were 2015 and 2016 (Figure 4).

4.4. Visual inspection for Croatia

The comparisons of Croatian W and PROD in logs are plotted in Figure 5. We can recognise that the results for Croatia differ more than this is the case for Slovenia. Because of high (summer) seasonality, Croatian tourism sub-industry suffers volatilities in PROD and W, and therefore do not match optimal measure (Figure 5).

High seasonality and volatility require that all variables should be transformed into at most first differences (Table 3, Figure 6). For Croatia, Figure 6 reports that W^r_{t-1} is not optimised; W is largely dispersed and obviously not under control in the Croatian tourism sub-industry. The latter is obvious for all the analysed periods and W^r_t is more stable only after 2015. Similar for Slovenia, but at a slightly higher seasonality could be seen for pattern in development for $PROD_{t-1}$ variable. The latter is due to very high summer output and lower output in the rest of the year. The difference between the summer and autumn periods is 9:1.

Figures 4 and 5 show that the average level of labour productivity in Croatia is much higher than in Slovenia. This can be explained by some new developments in the tourism and sharing economy markets such as Airbnb, Booking.com and similar platforms providing tourist accommodation without employment in the hotel industry, as an issue for further research (Vinogradov et al., 2020).

4.5. Granger causality test comparisons, ECM, VAR and forecast

Pair-wise differences on both countries are analysed using Granger Causality test (Table 4). Results at lag two for *both countries* cannot reject H_0 that there is no causal relationship between W^r_{t-1} and $lnPROD_{t-1}$.

Value of strong significance at zero % (or less than 1%) level confirms that $lnPROD_{t-1}$ causes lnW^r_{t-1} in Croatia. On the other hand, lnW^r_{t-1} does not cause $lnPROD_{t-1}$ in Croatia by p value of 0.59. Therefore, lnW^r_{t-1} does not provide any increases of $lnPROD_{t-1}$, which can be explained by relatively low real gross wage close to their minimum value as demanded by Croatian tourism trade unions, while managers might seek for prolonged seasons, but keeping W low to reduce costs.

The result at lag two for *Slovenia* rejects H_0 that there is causal relationship between $lnPROD_{t-1}$ and, lnW^r_{t-1} but not vice versa. Considering the alternative hypothesis, this confirms that there is a strong uni-directional causal relationship between $lnPROD_{t-1}$, and lnW^r_{t-1} for Slovenia. On the other hand, lnW^r_{t-1} does not

Table 4. Granger Causality test for Croatia and Slovenia and ECM.

Direction of Causality	Number of lags	F value	Decision	Remarks
Croatia; $\chi^2 = -4.59^{***}$; $lnW^r_t = 1.00 \cdot lnW^r_{t-1} + 0.00 \cdot lnPROD_{t-1} - 0.47 \cdot \varepsilon_{t-1}$				
$(168.0)^{***}$ (0.24) $(-7.75)^{***}$				
$lnPROD_{t-1} \rightarrow lnW^r_{t-1}$	2	12.95***	Reject	strong significance
$lnW^r_{t-1} \rightarrow lnPROD_{t-1}$	2	0.54	Cannot reject	no significance on $\rho = 2$
Slovenia; $\chi^2 = -2.98^{*}$; $lnW^r_t = 1.03 \cdot lnW^r_{t-1} - 0.03 \cdot lnPROD_{t-1} - 1.10 \cdot \varepsilon_{t-1}$				
$(1.91)^{**}$ $(-3.25)^{***}$ $(-2.02)^{***}$				
$lnPROD_{t-1} \rightarrow lnW^r_{t-1}$	2	9.88***	Reject	strong significance
$lnW^r_{t-1} \rightarrow lnPROD_{t-1}$	2	0.06	Cannot reject	no significance on $\rho = 2$

*10% significance level.
**5% significance level.
***1% significance level.
Source: author's calculation.

cause $lnPROD_{t-1}$ in Slovenia by p value of 0.95. Therefore, lnW^r_{t-1} does not provide any increases in $lnPROD_{t-1}$,

Results of ECM in Table 4 corresponds to the intuition of one cointegration vector between the variables. We found that two series are cointegrated in a linear form since the residuals are weakly normally distributed. Note that we have calculated residuals in differenced data, whereas the data in levels do not confirm any unidimensional Engel and Granger cointegration. Therefore, residuals are attached to the data vector and lag them by one period to estimate ECM out of Equation (8), as:

$$\Delta W^r_t = \alpha + \hat{\beta}_{i\ j} \cdot \Delta W^r_{t-i} + \gamma_{i\ j} \cdot \Delta PROD_{t-i} \pm\ \hat{\rho}\ \cdot \hat{\varepsilon}_{t-1}, \tag{11}$$

where $\hat{\rho}$ is estimated long-term relationship coefficient and $\hat{\varepsilon}$ is the deviation of from long-term relationship in the previous period. It is vital to note that $\hat{\rho}$ is negative and an ECM is appropriate. The lagged residuals from the linear regression represent the deviation from the long-term relationship in the previous period.

The intuition is if real gross wage is above its long-term equilibrium with the market (PROD), the negative coefficient pulls it back down. This is a case for Slovenia. If it is below the long-term equilibrium, the negatives disappear and become positive pulling the gross wage back up. That is the magic of the ECM for Croatia. The coefficient can be interpreted as the proportion of disequilibrium that dissipates by the next period. Therefore, the results significantly confirm our statements that there is a decline in real gross wages in Slovenia, and no changes in real gross wages in Croatia. The new equilibrium for Slovenia is a bit more than a month, and for Croatia is a half of month. Croatia has two times faster productivity change that corresponds to the real gross wages.

Additionally, spatial autoregressive model (Equation 10) with four variables, 2 lags, rank of three, one stochastic trend, and one deterministic shift dummy for August 2019, as a contrast to the ECM, is estimated. Based on the in-sample results, the pairwise ECM seems to have inside country explanatory power and the VAR model has spatial power on three cointegrated vectors. Nevertheless, testing the VAR the whole vector ECM (VECM) output is performed in cointegration relations, restrictions on beta and p values, which are in parenthesis:

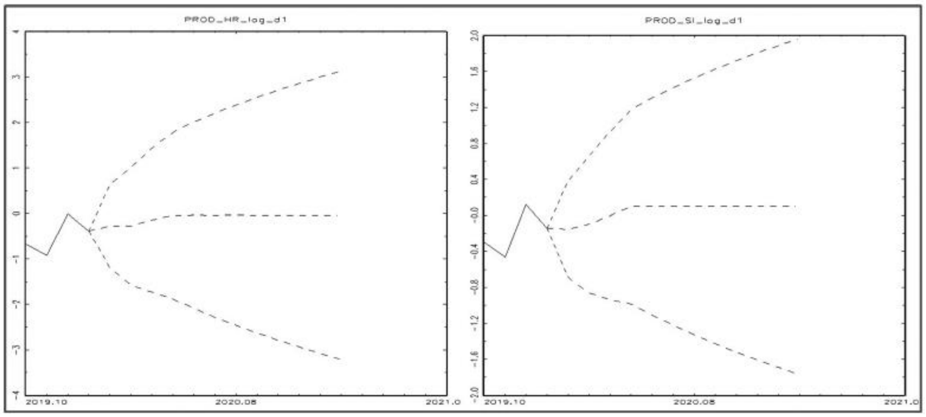

Figure 7. Prediction of labour productivity (PROD) for Croatia and Slovenia.
Notes: PROD_HR_lpg_d1 – forecast for Croatia; PROD_SI_lpg_d1 – forecast for Slovenia.
Source: author's calculation.

$$ec1_t\Delta PROD_{HR\ t} = \underset{(0.00)}{0.509 \cdot \Delta PROD_{HR\ t-1}} - \underset{(0.00)}{0.538 \cdot \Delta PROD_{SI\ t-1}}$$

$$+\underset{(0.00)}{0.02 \cdot \Delta W_{HR\ t-1}} + \underset{(0.05)}{0.01 \cdot \Delta W_{SI\ t-1}} + \varepsilon_{t-1}, \tag{12}$$

$$ec2_t\Delta PROD_{SI\ t} = \underset{(0.00)}{-1.68 \cdot \Delta PROD_{HR\ t-1}} - \underset{(0.00)}{1.64 \cdot \Delta PROD_{SI\ t-1}}$$

$$+\underset{(0.58)}{0.01 \cdot \Delta W_{HR\ t-1}} - \underset{(0.02)}{0.04 \cdot \Delta W_{SI\ t-1}} + \varepsilon_{t-1}, \tag{13}$$

$$ec3_t\Delta W_{HR\ t} = \underset{(0.00)}{2.96 \cdot \Delta PROD_{H\ t-1}} + \underset{(0.22)}{0.56 \cdot \Delta PROD_{SI\ t-1}}$$

$$\underset{(0.00)}{-1.57 \cdot \Delta W_{HR\ t-1}} - \underset{(0.01)}{0.14 \cdot \Delta W_{SI\ t-1}} + \varepsilon_{t-1}, \tag{14}$$

where eigenvalue of lag reduction test (LR) for cointegration rank (trace test statistics) is 51.93. The rank of three $r = 3$, has p-value 0.000 (trace test statistic is 16.22), while one unit root is clearly accepted. This result confirms three cointegration relations at 1% significance level as well as that there is no autocorrelation. Three cointegrated vectors confirm spatial development between Croatia and Slovenia, whereas there is no significant determination to national real gross wages from the neighbour countries on PROD (14).

The one-year forecast, that includes health COVID-19 crisis as two and half month lockdown (0.5 of March, April, May), based on VECM model for PROD presented in Figure 7, seems to be negative for Croatia for next 12 months. Slovenia would start a slow recovery in May 2020.

5. Conclusion

Econometric modelling refers to the relevant macroeconomic time series and developments in the tourism market of the two neighbouring EU Member States, Croatia and Slovenia. The specific focus is on tourist arrivals, gross wage in tourism subindustries, and employment in lodging industry. Inflation is applied as external variable. Selection of specific variables is made based on the set hypothesis and previous empirical research (e.g., Dimitrić et al., 2019).

This research is relevant for tourism facing missing strong links between labour productivity and real gross wages. Findings of the paper are three-fold. First, the data vector includes long-term and promote several transitory shocks, e.g., EU accession, and economic crisis period. Second, analysis proposes possible scenario to tourism after pandemic crisis. Third, this research prompts the calculus for real gross wages and productivity, without producing autocorrelation in the econometric modelling.

Croatia and Slovenia tend to increase the level of tourism output outside the summer season. The tourism managers should be aware that low paid employees could not be sufficient for high demand and tourist output with a high quality of services. Increase in a labour productivity with higher quality of services could improve customer satisfaction and the whole year employment. Policy makers tend to increase the aberrance for tourist destinations in Slovenia and Croatia for the whole year as a part of strategies of sustainable tourism development.

The results show that labour productivity in Croatian and Slovenian tourism subindustries have uni-directional causal relationship on real gross wage in tourism subindustries. Labour productivity drives real gross wage, consistent with alternative hypothesis. The ECM predicts a decrease in labour productivity in Slovenia and decline in real gross wages in a next one-month period. Due to the COVID-19 crisis the prediction of VECM model confirms a decline in labour productivity for Slovenia up to May 2020.

On the other hand, ECM does not suggest any statistically significant change in labour productivity for Croatia. The change in labour productivity, if occurs in a short-term as proposed by Granger causality results, dissipates in a half of month. Due to the COVID-19 crisis, the prediction of VECM confirms decline in labour productivity for Croatia, mostly to its ARR and it lasts up to at least a year.

Tourism industry comprises of a wide variety of products, services and destinations involving various stakeholders, external and internal. These activities are sensitive to numerous shocks. In the last decades the tourism industry generated self-managing services based on information-communication technology which also enabled employees to generate new knowledge and skills.

5.1. Limitations and practical applicability

Among study limitations, the empirical analysis was conducted at aggregated tourism level and would be useful to apply at disaggregated levels such as transportation, and for new developments in the tourism and sharing economy markets (Airbnb, Booking.com and other possible tourist accommodation providers). The analysis is based on linear cointegration methods and in the future research would be useful to apply panel cointegration. Moreover, the transitory, permanent and blip shocks could be specified in the model to avoid non-normality.

The empirical approach has defined practical applicability to study various shocks, particularly the COVID-19 crisis in 2020s. Tourism labour market in both countries is less developed and under researched. Moreover, labour productivity in tourism service sector is challenged by application of new digital technologies, including robots and artificial intelligence. However, employees still play a crucial role in supply of tourism services. The new technologies could be issues for the future research, i.e. self-moving chair to avoid transmission of bacteria by chair.

To sum up, the research provides in-depth analysis and gives information and knowledge to managers for better understanding the causalities between real gross wage and labour productivity in tourism sub-industry. A spatial analysis between the two neighbouring countries offers answer to the question why policy makers and managerial decisions could be important for management of labour productivity and wage formation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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9.6 ATTACHMENT 4.

Modelling seasonal short-run effects in time-series tourism prices

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Article

Modelling Seasonal Short-Run Effects in Time-Series Tourism Prices

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Abstract: The paper's primary purpose is to better monitor shocks; therefore, reliable scientific methods should be used to predict, monitor, and implement those events. In this paper, tourism prices are studied as an economic, $I(2)$ and social phenomenon for better performance. The selection of inadequacies in price time series is analysed. The state-of-the-art proposed methodology step of nominal to real prices is based on monthly data using the cointegrated-vector-autoregressive model (CVAR). This is the key feature selection on time-series properties in the economy and supported software(s). An attempt at a CVAR model with five seasonally unadjusted macroeconomic variables is developed. It introduces a meaningful, genuine and indispensable new data vector of transformed variables, and this stepwise process is more appropriate against the wrong model specification. The results for the period of economic crises show that the proposed model is reliable from nominal to real prices, and the researchers implement normality to price modelling in its econometric mock-up phase. Overall, the proposed model predicts testable events for up to 48-months.

Keywords: nominal to real price modelling; cointegrated-vector-autoregressive-model; Eurozone experiment; time-series data; macroeconomic prices

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1. Introduction

Predicting tourism industry prices are essential for both inbound and outbound tourist destinations (Gričar and Bojnec 2019). Understanding the market functioning and economic behaviours; the importance of prices is critical to market economies (Couix 2021; Lemieux 2020). Therefore, the study's objective is to develop a normal distributed econometric model for prices based on the methodology from nominal to real price modelling (Ross 2021; Chen et al. 2021). Our study is motivated to complement the applied economics methodology using publicly available secondary data (Couix 2021).

The primary objective of this research is to develop a cointegrated vector error correction (CVAR) model following Cubadda (1999), Busetti (2006), Fisher et al. (2015), Rahul et al. (2018) and Archontakis and Mosconi (2021) for better diagnosis and prediction in the financial and tourism industry. We develop and discuss time series, seasonal, $I(2)$ and misspecification patterns for tourism inflation (Braun et al. 2013) without performing deseasonalisation to keep the data most informative (Juselius 2009).

The identified research gap has been discussed in the literature, but more often theoretically and less frequently with an applied case study. Therefore, we aim to fill the gap in the literature by demonstrating the importance of variables in aggregate values in the economy. While volatility is high in financial time series, gross domestic product (GDP) is treated as $I(0)$, inflation as $I(1)$ and prices as $I(2)$.

The novelty and contribution of this study are to develop an econometric model of mixture $I(1)$ and $I(2)$ (Fisher et al. 2015), while $I(2)$ differentiation is rarely presented in scientific literature and therefore worth researching. Moreover, the research aims to investigate hypotheses for short-term seasonal effects (Busetti 2006) in prices over the usual business cycles (Cubadda 1999). A step-by-step presentation shows the correctness of econometric technical processing of time series in $I(1)$ processing, while this is mostly in general or partially omitted in applied quantitative tourism research.

Econometric methods allow analyses for price spreads and seasonal effects to vary in response to shocks (Alghalith 2007). Our procedure leads to a more robust model for misspecification, which is essential to avoid spurious results. A unique contribution is related to the two-sided effects on the economy and the possible existence of seasonal impacts on tourism prices (Claverla and Torra 2014) in the Eurozone, focusing on Slovenia as a case study using monthly statistical time series data.

The data vector is split into the testable period. The division of the time vector follows the Organisation for Economic Cooperation and Development (OECD 2013), which states that green tourism has to be started and will last for many years. Therefore, the data vector (2000–2017) considers tourism prices as critical growth factors. During these periods, potential shocks can be related to specific events and developments such as Slovenia joining the European Union (EU) and adopting the euro, experiencing high food prices, witnessing economic crises, and economic growth. The focus is on the hospitality sector within the tourism industry, which makes up the most significant part of the tourism industry in Slovenia.

The paper's primary goal is to present volatilities in economics time series data to show how they can be treated in econometrics beyond misspecification tests. The rest of the paper is divided into four sections: literature review, the methods and data used, presentation of the results, and discussion.

2. Literature Review

In Dash and Parida's (2013) and Kumar and Patel's (2021) studies, cointegration was used to model tourism demand and forecasting. The evidence was linked to unit root tests and structural breaks (Capelli et al. 2021; Lin and Huang 2012). In addition, Kunst and Frances (2015) investigated seasonal time shifts in weekly time series.

Some studies (Claverla and Torra 2014) have identified continuity cycles; there have been few research efforts aimed at analysing time series data (Qi et al. 2012) in a dynamic regression model using a vector autoregressive model (VAR) (Kulendran and Witt 2001). The stability of responses to price changes can be affected by different determinants in people's expectations and the national economic situation (Smeral 2012).

Time-varying volatility is in the direction of a dynamic regression model (Harvey 1989; Song et al. 2009), as the model VAR (Juselius 2015; Koukouritakis et al. 2015). This can imply stubbornness in the specification of the tourism model and allow for structural instability (Harvey 1989; Song et al. 2009; Koukouritakis et al. 2015). The time-varying parameters approach (Braun et al. 2013) gives more weight to the most recent data evaluating tourism demand and price models and leads to more accurate projections than the commonly used regression models (Kulendran and Witt 2001). This step is essential to capture structural changes or unanticipated shocks (Juselius 2015) in econometric models of tourism (Song et al. 2009; Claverla and Torra 2014; Kumar and Patel 2021).

The time-varying parameter approach (Qi et al. 2012) is functional when dealing with structural changes (unexpected shocks) (Kulendran and Witt 2001; Koukouritakis et al. 2015) but does not provide robust results when testing the assumption that the value of the elasticity varies depending on the phase of a particular business cycle (Smeral 2012) of the economy or unexpected shock (Juselius 2015; Kumar and Patel 2021). This is crucial for predicting conditions (Claverla and Torra 2014) typical of an economic downturn or stagnation, with different price consequences at various stages of prosperity (Smeral 2012). Moreover, using the recursive ordinary least squares (OLS) method shows that the assumption of coefficient constancy is too restrictive (Song et al. 2009) and that macroeconomic variables are highly dependent (Juselius 2015).

This paper critically examines the approach of simple static regression analysis, a commonly used statistical technique (Johansen 2012; Juselius 2015), and highlights the validity of the underlying assumption of simple static regression analysis to draw attention to some shortcomings where this method cannot be routinely used. This is the case when variables are non-stationary (Kulendran and Witt 2001), either because they exhibit a deterministic trend (Papell and Prodan 2014) or, more commonly in macro econometrics, a stochastic trend (Juselius 2015; Huang et al. 2015).

A demonstration of the econometric model is evidenced by the econometric composition agreeing and suggesting the non-stationary variables (Johansen 2012) when implementing the CVAR model, which can better express the understanding of the variation of the time series vector (De Mello and Nell 2005). CVAR application can be highly relevant to a better understanding of time series data. The concern about the misuse of correlation coefficients between economic variables is also applicable in determining variables. The CVAR thwarts the problem of trend adjustment by specifying the general VAR in terms of an error correction that includes all deterministic components: Trend, Constant, and Dummy Variables (Juselius 2015; Dash and Parida 2013). In a dynamic regression model such as the VAR, a dummy variable controls for the unexpected shock but leaves the measurement unaffected. This contrasts with a regression model where a dummy variable usually eliminates the measure of the irregularities in time-series development (Kulendran and Witt 2001; Juselius 2009).

Emerging and developing economies have mostly undergone a transition and have suffered from an inflation treatment that exceeded the main constant several times. Therefore, inflation was maximised by policy changes and minimised by external influences, such as the emergence of integration content. A subdued inflation rate was usually seen as costly in output losses and adjustments of tourism prices to seasonal changes. However, a better understanding of the role of assumptions has given policymakers hope that credible monetary and industrial policies can achieve disinflation without negatively affecting actual economic activity in tourism (Baxa et al. 2015). The findings reveal deficiencies in research on macroeconomic variables in tourism and economics on the appropriateness of time series.

3. Materials and Methods

As a starting point is an illustrative example of two time-series X_t and Y_t, $t = 1, \ldots, T$, and a substantive theory (Kulendran and Witt 2001):

$$Y = \beta \cdot X, \tag{1}$$

that X influences Y in a linear fashion formulation.

The data obtained may not be in the same relation, and there is usually no theory behind them. Haavelmo (1943) argued that we need some deterministic proposal and problem to solve this stochastic property in odds, which should be as elastic as possible (Juselius 2022), which has been further developed by Johansen (2012).

We introduce:

$$Y_t = \beta \cdot X_t + \varepsilon_t, \quad t = 1, \ldots, T, \tag{2}$$

with the error term ε_t in a statistical relation (Juselius 2009).

When the model deals with the hypothesis about the parameter β that $\beta = 0$, linear regression and correlation analysis are essential. In this sense, the independent variables affect the dependent variable in a time frame on some lag, but the independent variables do not affect each other. First, the regression approach is used to estimate the effect of X on Y using the following expressions (Johansen 2012):

$$\acute{\beta} = \frac{\sum_{t=1}^{T} X_t \cdot Y_t}{\sum_{t=1}^{T} X_t^2}, \text{ and} \tag{3}$$

$$\acute{\sigma} = T^{-1} \cdot \sum_{t=1}^{T} (Y_t - \acute{\beta} \cdot X_t)^2, \quad (4)$$

by calculating the least-squares estimators and the residual error variance. These interpretations are then used to perform boundary behaviour inference by analysing the t-ratio:

$$t_{\beta-\beta_0} = \left(\sum_{t=1}^{T} X_t^2\right)^{1/2} \cdot \frac{\acute{\beta} - \beta_0}{\acute{\sigma}}, \quad (5)$$

with the quintiles of a standard normal distribution. The regression approach straggles well if the estimators $\acute{\beta}$ and $\acute{\sigma}^2$ are halt to their analytical observes, β and σ^2 and if the boundary behaviour distribution $t_{\beta-\beta_0}$ is close to the Gaussian distribution (Johansen 2012).

Second, a widely known problem of normally distributed residuals ε_t is i.i.d. $N(0, \sigma^2)$ in regression analysis that does not link empirical regression to theoretical values. There is also the issue of stationarity and X_t is nonstochastic (Qi et al. 2012). Similarly, if (X_t, Y_t), then is i.i.d. Gaussian with variances σ_1^2, σ_2^2, and covariance σ_{12}. The theoretical correlation is then $\rho = \sigma_{12}/\sigma_1 \cdot \sigma_2$, and the maximum likelihood estimator of ρ is $\acute{\rho}$. In addition to saying it has a publicly refreshed idea not to check the model and compare the econometric model as it fits the data, it just seems to click on the computer as a very convenient task (Johansen 2012). Testing the model with multiple indicators and plots gives the researcher a model-based and suitable econometric approach, i.e., providing accurate results (Kulendran and Witt 2001; Juselius 2015).

To further discuss the vulnerability of the econometric conclusions, the modelling process is the subject of this research, while the evaluation of the systems with applied economic results is of great importance, which increases after each negative shock. The methods used in the applied part of the research are regression analysis, VAR CVAR models and Granger Causality.

3.1. Regression Model

The regression model in its statistical version is performed as written in Equation (2) where $\varepsilon_1, \ldots, \varepsilon_T$ permutations in the commitment that they are, i.i.d. (0, σ^2) and ε_t is independent of $X_1, \ldots, X_t$, $t = 1, \ldots, T$; $X_1, \ldots, X_t$ are variables in their stochastic or deterministic dispersion and statistical inference conforms to linear constraints (Johansen 2012):

$$n_T^{-1} \sum_{t=1}^{T} X_t^2 \xrightarrow{P} \sum > 0, \quad (6)$$

for some sequence $n_T \to \infty$.

Here $\xrightarrow{P}$ stands for convergence in expectation (Hall and Heyde 1980). Johansen (2012) shows four results when the regression method works well.

The following approach is used when the regression approach may fail using the time series data. When it cannot be normalised

$$\sum_{t=1}^{T} X_t^2, \quad (7)$$

in a way that the limit exists as a deterministic limit, it can be called a random walk regressor. In the case that $\xi = 1$, then there is a unit root, so that X_t is stochastic and non-stationary (Kulendran and Witt 2001; Huang et al. 2015) in the sense that (Johansen 2012)

$$X_t = \sum_{i=1}^{t} \varepsilon_{2i} + X_0, \quad (8)$$

and in this case, $E(X_t \mid X_0) = X_0$ and the variance $Var(X_t \mid X_0) = \sigma_2^2 \cdot t$, which increases to infinity. However,

$$T^{-2} \sum_{i=1}^{T} X_t^2, \quad (9)$$

sets a stochastic variable and does not converge to the deterministic term. The detailed theory involves Brownian motion (Johansen 2012), an uninterrupted stochastic operation defined on the unit interval $0 \leq u \leq 1$ by random walks. Two fundamental results of the

Brownian motion are stochastic variables. Convergence in modelling is normalised for this study to product moments, which should be T^2 and T, respectively. The significance is that the stochastic implication is imposed (9), while it is based on the conditional process. The regression coefficient satisfies:

$$\hat{\beta} \xrightarrow{P} \frac{\mu_1}{\mu_2}, \tag{10}$$

this is the ratio of the slopes of the trends. An applied analysis of the time-series data, using models:

$$\Delta Y_t = \varepsilon_{1t} + \mu_1, \tag{11}$$

and

$$\Delta X_t = \varepsilon_{2t} + \mu_2, \tag{12}$$

is to make linear assumptions for each contained variable and estimates of μ_1 and μ_2 to talk freely about the information contained.

It is of utmost importance that the variables in the time series approach are entirely uncorrelated, as they are not variables in levels, which is why a regression approach is invalid, while in the case of correlated variables, they are distinguished by a third term, which most likely corresponds to a time trend (Juselius 2009, 2022). It is critical to note that in the calculus of correlations to replace $E(X_t)$ and $E(Y_t)$ by acceptable estimates we should not use the time series data averages.

3.2. The Cointegration and VAR Model

The random walk (De Mello and Nell 2005) and co-relations (Granger 1981) in macroeconomic variables are higher-order problems; hence, cointegration was introduced (Juselius 2022). Engle and Granger (1987) tested cointegration by applying regression models. Phillips (1991) and Johansen (1988) identified the valid interpretation of the regression model and noted the autocorrelation problem within the cointegration exercise. The technique of cointegration has become a research approach in time series econometrics and statistical computer program packages, such as CATS for RATS (Dennis et al. 2005).

We consider two variables X_t and Y_t, which are generated by the equations (Johansen 2012):

$$\Delta Y_t = \tau \cdot (Y_{t-1} - \gamma \cdot X_{t-1}) + \varepsilon_{1t}, \tag{13}$$

$$\Delta X_t = \eta \cdot (Y_{t-1} - \gamma \cdot X_{t-1}) + \varepsilon_{2t}, \tag{14}$$

for $t = 1, \ldots, T$. The linearity in each variable is progressive. The time series contains information from the past, but it should be noted that the levels of the variables Y_{t-1} and X_{t-1} all occur in the same order

$$U_{t-1} = Y_{t-1} - \gamma \cdot X_{t-1}, \tag{15}$$

in each of the comparisons. The U_{t-1} is the disequilibrium error and the consumption $Y = \gamma \cdot X$ as a mean relation. Thus, the variables respond with adjustment coefficients τ and η, respectively.

Such a model contains a stationary variable part and a random walk, generating non-stationary variables. Interestingly, the combination in a linear sequence is stationary so that the linear combos $(1, -\gamma)$ eliminate the common trend (random walk). Thus (X_t, Y_t) is non-stationary but has a property of a collected time series variables and has a cointegrating vector $(1, -\gamma)$ and routine stochastic trend S_t (Granger 1981).

It is worth noting that unlike a regression of Y_t as a function of X_t, the variables are treated and modelled similarly. Thus, for example, if $Y_t - \gamma \cdot X_t$ is stationary; after that, the result is $\gamma^{-1} \cdot Y_t - X_t$. The normalisation procedure could therefore be provided on non-zero coefficients on both variables.

In cointegration, there is no causality processing, underlined by the VAR model with two lags and constant within the n—dimensional process and X_t is developed by the equation:

$$H_r: \ \Delta X_t = \alpha \cdot \beta' \cdot X_{t-1} + \Gamma \cdot \Delta X_{t-1} + \mu + \varepsilon_t, \tag{16}$$

where the white noise process $\varepsilon_t = x_t - \mu_t$ is the difference between the stipulatory mean μ_t and true comprehension X_t, which usually is independent $NI_n(0, \Omega)$, $t = 1, \dots T$, and $(\alpha, \ \beta)$ are $n \times r$ matrices, r is cointegration rank, X_{t-1} are past values of the variable, ΔX_t is differenced variable, μ is a mean vector for all periods T, and Γ is a covariance matrix (Johansen 2012). The technical process of $I(1)$ has the relevance of avoiding obstacles in distinguishing error specifications, such as the i.i.d. assumption of error terms and plot analysis. Most importantly, the lag lengths should be examined to check the time series assumption behind the model and finally to identify the cointegration rank for estimating the model under the development interpretation. In conclusion, the beta-normalised constraints on zero are essential (Johansen 2012; Juselius 2022).

It is essential to check the rank of α and β in time series to obtain the number of cointegrations. The starting point is the unrestricted model VAR:

$$H_n: \ \Delta X_t = \Pi \cdot X_{t-1} + \Gamma \cdot \Delta X_{t-1} + \mu + \varepsilon_t, \tag{17}$$

where ε_t i.i.d. $N(0, \Omega)$ and Π, Γ, μ, and Ω are unrestrained. The cointegrating relation is assumed over r and is formulated as in the VAR model with two lags and a constant term:

$$\Pi = \alpha \cdot \beta', \tag{18}$$

where α and β are $n \times r$ matrices $(n \ < \ r)$ and the r combinations $\beta' \cdot X_t$, which define the stationary relation of non-stationary variables (Juselius 2015). In conjunction with maximum likelihood estimators, estimators can be computed definitively by an eigenvalue problem, even if it is a non-linear maximisation snag for a separate rank regression or for introducing cointegration (Johansen 1988). The latest provides estimators $(\check{\alpha}, \check{\beta}, \check{\Gamma}, \check{\mu}, \check{\Omega})$, calculated from:

$$-\frac{T}{2}\left[logdet(\Omega) \cdot - \frac{1}{2}tr\{\Omega^{-1} \cdot \textstyle\sum_{t-1}^{T} \varepsilon_t(\Pi, \ \Gamma, \ \mu) \cdot \varepsilon_t(\Pi, \ \Gamma, \ \mu)'\}\right], \tag{19}$$

and the highest point L_{max} (H_r). At this point, the input is a misspecification test. The model's boundary is perceived by a unit root test developed by the so-called Dickey-Fuller -test (Dickey and Fuller 1981) for the uni-modelled process and the misspecification test for the multivariate VAR model depending on one or more deterministic terms. Overall, modelling procedures include not only the chi-squared test but also the likelihood ratio test or the $t-$test statistic, where $\chi^2(f)$ in an f recognises the number of restrictions used in a parameterisation procedure (Johansen 2012; Juselius 2015, 2022).

3.3. The CVAR Model

Shocks are a common problem in economics. Volatility in series called shocks or breaks provide several valuable pieces of information for researchers. Such a violation pushes the variables out of the mean or equilibrium. In comparison, high correlation matrix coefficients affect the predictability and usefulness of time series modelling and reveal biased results. Therefore, ordinary stochastic trends are required in bivariate cointegration, but only more than two variables are usually needed to produce cointegration. Illustrational cointegration is more related to multiple regression, with one significant difference. The cointegration results are sensitive to the length of the data vector, while the regressors in regression are sensitive only to orthogonality. The importance of such thinking in an economic modelling process creates non-multicollinearity, while cointegration is realised in the set of variables. (Kulendran and Witt 2001; Juselius 2015). We present the CVAR model (De Mello and Nell 2005) applied to analyse the tourism time-series (Kunst and Frances 2015) data considering the non-stationarity. The CVAR model circumvents the problem of misuse of correlation coefficients between economic variables by inventing the VAR in the error-correction model (Juselius 2009; Kulendran and Witt 2001):

$$\Delta X_t = \mu_0 + \Pi \cdot X_{t-1} + \Gamma \cdot \Delta X_{t-1} \ldots + \Gamma_{k-1} \cdot \Delta X_{t-k+1} + \Phi \cdot D_t + \varepsilon_t, \;\; t = 1, \ldots T, \quad \varepsilon_t \sim NID(0, \textstyle\sum), \tag{20}$$

where $\Phi \cdot D_t$ includes each deterministic component (trend, constant, and dummies). The hypothesis that X_t is integrated of order one ($X_t \sim I(1)$) is invented as a reduced rank condition (18). For simplicity, only two lags are included in (Johansen 2012) the CVAR model, which leads to:

$$\Delta X_t = \mu_0 + \alpha \cdot \beta' \cdot X_{t-1} + \Gamma_1 \cdot \Delta X_{t-1} + \Phi \cdot D_t + \varepsilon_t, \;\; t = 1, \ldots T, \quad \varepsilon_t \sim NID(0, \textstyle\sum) \tag{21}$$

by converting the trending variables, X_t, into stationary differences, ΔX_t, and stationary cointegration relations, $\beta' \cdot X_t$, the multicollinearity is solved. One can find stationarity between the components of the regression and correlation coefficients, which are now well defined for given β, and standard inference (α, Γ_1, $\sum$) holds. The model is non-linear in α and β, but can be evaluated by the reduced rank proposed by Johansen (1988) where the β factors are treated as the eigenvectors to a mix of an eigenvalue problem, and α is calculated by linear regression for given β. The definitions $\beta' \cdot X_t$ define r linear relationships between n variables.

4. Results

We use five seasonally unadjusted monthly time series price variables. The in-sample is from January 2000 to May 2012, and the out-of-sample is from June 2012 to December 2017. The specified variables are: Slovenian prices in the hospitality industry ($IPHI_t$), prices in the hospitality industry in the Eurozone ($IPHIEA_t$), Slovenian consumer prices (CPI_t), consumer prices in the Eurozone ($CPIEA_t$), and Slovenian food and beverages prices (IFB_t) as input costs for the hospitality industry. The initial VAR methodology is used, and the price differences are involved in the approach.

The data are obtained from the Statistical Office of the Republic of Slovenia (SORS 2021) and Eurostat (2021).

4.1. Inflation and Tourism Prices

4.1.1. Regression Analysis

Following the introduced simple static regression model in Equation (2), we would like to find effects on the $IPHI_t$. Hence, $IPHIEA_t$, CPI_t, $CPIEA_t$, and IFB_t are the most likely determinants influencing the $IPHI_t$. Calculating the static regression model in Equation (2) with the used explanatory variables, we get the following regression results:

$$IPHI_t = \underset{(6.270)}{1.527} \cdot IPHIEA_t - \underset{(-1.470)}{0.139} \cdot CPI_t + \underset{(3.292)}{0.832} \cdot CPIEA_t + \underset{(5.857)}{0.335} \cdot IFB_t + SD, \tag{22}$$

where SD denotes seasonal dummy variables. From the t-test numbers in the brackets can be seen the statistical significance of the regression parameters. A final step is to transform variables with seasonal adjusting. We get:

$$IPHI_t = \underset{(7.246)}{2.478} \cdot IPHIEA_t - \underset{(-2.852)}{0.277} \cdot CPI_t + \underset{(0.140)}{0.045} \cdot CPIEA_t + \underset{(5.186)}{0.288} \cdot IFB_t - \underset{(0.400)}{0.053} \cdot t, \tag{23}$$

where the time variable t runs from 1 to 129. High statistical significance is observed by almost regression parameters of all variables, except for $CPIEA_t$. The Durbin-Watson statistic is lower than 2 (0.813), indicating the presence of autocorrelation (Kulendran and Witt 2001). The adjusted determination coefficient is high at 0.992, and F statistic is significant by 3005.9.

The partial autocorrelation graphs confirmed the first and twelve lags, and the autocorrelation are at least in the first order. The residuals are not i.i.d. Results show spurious regression (Kulendran and Witt 2001) and cannot be normalised as a deterministic limit as explained in Equation (7). There is a unit root, and X_t is stochastic and non-stationary theoretically expressed as explained in Equation (8).

Time series for inflation can be considered stationary or non-stationary (Baxa et al. 2015). This statement is due to a unit root process (stochastic trend), and inflation should instead be treated as a non-stationary variable. It is crucial to start with a shorter duration, 3 to 5 years, which leads to a non-stationary formulation, and the cyclical component can be further studied in a more extended period, e.g., 13 years, for the example of this approach. Nevertheless, this is tested in the forecasting OLS in Appendix H.

The distinction between short- and long-term cycles is that a long/short term cycle can be treated as either non-stationary or stationary, depending on the time perspective of the work (Juselius 2022; Gričar and Bojnec 2021).

Juselius (2009) shows that prices enter a two-sided inverse stochastic trend that can be written as $P_t \sim I(2)$ when the inflation rate is integrated with a non-zero mean. The order of integration is known as the number of times a series should be differentiated to achieve stationarity (Kulendran and Witt 2001). Most research treats variables in levels or seasonally adjusted terms and rarely examines parameters involving real variables and their transformations. This contributes to the fact that prices are standardised in the almost second order of integration (Gričar and Bojnec 2019). $IPHI_t$, $IPHIEA_t$, CPI_t, $CPIEA_t$, and IFB_t should be preceded by the $I(1)$ analysis of the real price variables (Juselius 2009).

4.1.2. The Data Vector

An additional formulation is obtained by taking logarithms, where now *new* names of variables indicate a logarithmic transformation and a symbol R indicates that the variable was transformed from nominal to real, r indicates real t time series variable, and variables are at least $I(1)$; $X_t^r \sim I(1)$. Therefore, we decided to use the logarithms transformed $CPIEA_t$ and $IPHIEA_t$. We have transformed variables from nominal to real prices using i.i.d. process checking to become stationary in $I(1)$.

Data on time-series prices are at most $X_t \sim I(1)$ (Juselius 2009). We get the data vector: $[rph\ rp\ rfbp\ dpea\ dphea]_t^T$, $t = 2000:1, \ldots, 2012:5$, whereas the minuscule letters define normally distributed residuals, e.g., real or differenced variables. The transformation procedure is in Appendix A.

To clarify precisely whether the variables are endogenous or exogenous, it is essential to look at them from a stochastic point of view. They are tested for long-run cointegration as explained in Equations (13) and (14) using OxMetrics (CATS for RATS) software (Tufte 1998). In the short run, seasonal effects were calculated in a dynamic error correction model explained in Equations (20) and (21) using OxMetrics software.

4.1.3. Misspecification Test

The formal misspecification tests (Appendix A, Table A1) have confirmed that the VAR model neither contains autocorrelations nor heteroskedasticity in the residuals. We also assume the test of normality formed on skewness and kurtosis of the standardised estimated errors. The null hypothesis of the normality test is not rejected ($p = 0.356$). Checking the stability of the VAR model, this derives to the conclusion that there are several permanent dummies needed for analysing structural breaks and/or shocks (Çağli and Mandaci 2013; Lin and Huang 2012), where the most obvious one, by using the visual inspection of the VAR model, was a shift dummy for high decreasing prices in the hospitality industry in September 2010 (D_s109_t). This dummy is foremost valid to normalise the cointegration equations. Other permanent dummies as a one-time effect (Kulendran and Witt 2001) are: the 11 September attack (September 2001), the euro having been circulated in its physical form (January 2002), decreasing the hospitality industry prices in the Eurozone (October 2004), a month before Slovenia adopted the euro (December 2006), and the period of high food prices (September and November 2007):

$$\Delta X_t = \Gamma_1 \cdot \Delta X_{t-1} + \alpha \cdot \beta' \cdot X_{t-1} + \phi_{p.1} \cdot D_p 019_t + \phi_{p.2} \cdot D_p 021_t + \phi_{p.3} \cdot D_p 0410_t + +\phi_{p.4} \cdot D_p 079_t + \phi_{p.5} \cdot D_p 0711_t + \phi_{p.6} \cdot D_p 0612_t + \phi_{s.7} \cdot D_s 109_t + \gamma_0 + \varepsilon_t, \quad (24)$$

are involved in the CVAR model in Equation (21) but not in the cointegration relations in Equations (25) and (26). The residuals from the estimated VAR (2) model with dummies now contains improved properties compared to the unconstrained model, as explained in Equation (16).

4.2. Specifying the VAR Model and Empirical Results

4.2.1. Test of Cointegration Rank, Long-Run Exclusion, and Stationarity

There are no trends in the variables' levels, but non-zero means exist in the cointegration relations. We restrict the CVAR model that the rank of Π is r, meaning that the five variables in the model have r cointegration relations and $n - r$ common stochastic trends. We estimated the CVAR model for $r = 1, 2, 3, 4, 5$. We consider the LR (Johansen 1988) trace test of cointegration rank. We have found the rank of two: $r = 3$ (Table 1), where p-value is 0.003. Moreover, $r = 2$ is at p-value 0.000, and $r = 4$ is at p-value of the trace test 0.440.

Table 1. Trace test.

n-r	r	Eig. Value	Trace	Trace *	Frac95	p-Value	p-Value *
5	0	0.440	229.666	218.780	107.400	0.000	0.000
4	1	0.403	144.973	137186	76.200	0.000	0.000
3	2	0.286	69.634	61.086	50.335	0.000	0.003
2	3	0.095	20.550	12.231	29.670	0.331	0.850
1	4	0.041	6.049	4.741	14.125	0.331	0.440

Note: r—number of ranks, n—number of variables, * = trace test statistics and p-values based on Barlett small sample correction, Frac95—the 95% quantile from the asymptotic tables.

We consider how to formulate tests of various hypotheses on the cointegration vectors. In the first step, we consider the test for the long-run exclusion of a variable, i.e., a variable that can be removed from the cointegration space. We have estimated the model with a $D_s 109_t$ and manually included the first difference with one lag, and we imposed a rank of $r = 3$. We will consider the Π matrix (Table 2).

Table 2. The combined effects Π matrix.

rph_t	***−0.002*** (−1.233)	−0.028 (−6.584) ***	0.020 (6.102) ***	0.358 (2.297) **	0.288 (1.070)	−0.002 (−4.929) ***	0.004 (3.888) ***
rp_t	−0.002 (−1.256)	**−0.031** (−7.129) ***	0.021 (6.374) ***	0.230 (1.459)	0.499 (1.832) **	−0.002 (−4.906) ***	0.004 (4.139) ***
$rfbp_t$	0.003 (0.826)	−0.017 (−1.777)	**0.011** (1.530)	1.119 (3.186) ***	−0.151 (−0.249)	−0.001 (−1.407)	0.000 (0.039)
$dpea_{t-1}$	−0.005 (−4.268) ***	0.009 (2.966) ***	−0.004 (−1.649) **	**−0.916** (−8.415) ***	−0.036 (−0.192)	0.000 (1.344)	0.002 (2.457) ***
$dphea_{t-1}$	−0.005 (−6.317) ***	0.006 (3.166) ***	0.001 (1.009)	0.068 (0.991)	**−0.896** (−7.592) ***	−0.001 (−3.479) ***	0.002 (4.173) ***

Notes: rph_t—Slovenian hospitality industry prices, rp_t—Slovenian consumer prices, $rfbp_t$—Slovenian food and beverages prices, $dpea_{t-1}$—consumer prices in the Eurozone, and $dphea_{t-1}$—prices in the hospitality industry in the Eurozone. The values of t-statistics are in the brackets and p-values are of ** 5%, and *** 1% level of significance; bold numbers indicate normalisation of cointegration relations.

The variable is excluded from the cointegration relations when the coefficients in the respective column of the Π matrix are insignificant. From the Π matrix in Table 2, there are no clear signs that any of the variables can be excluded from the cointegration relations, except for the rph_t (Table 3). The design matrix Π for the hypothesis that the first variable can be excluded from the cointegration relations is where s is the number of free parameters. We restrict one of the $n = 7$ variables (5 variables, shift, and a constant), and we have six free parameters.

The test of long-run exclusion (Table 3) can be performed automatically in CATS for RATS for different choices of rank. For a rank of $r = 3$, none of the five variables or the restricted level shift can be excluded from the cointegration relations, except for the rph_t. However, we have decided that the rph_t the variable will stay in the model specification because we would like to test long-term and short-term relations on this variable in a cointegration space. Moreover, if we choose a cointegration rank of $r = 1$, then we can exclude the rph_t, and $dpea_{t-1}$. Furthermore, the constant can be excluded so that the single cointegration relation in the model is a relation between the inflation rates and the food and beverage prices.

Table 3. Test of hypotheses on properties of the system variables ($r = 2$).

Test/Variable	rph_t	rp_t	$rfbp_t$	$dpea_{t-1}$	$dphea_{t-1}$	Dummy	C	χ^2
Long-run exclusion	2.642 (0.450)	9.938 (0.019) ***	9.805 (0.020) ***	66.445 (0.000) ***	43.375 (0.000) ***	11.629 (0.009) ***	25.160 (0.000) ***	$\chi^2(2) = 7.82$
Stationarity	11.581 (0.003) ***	7.809 (0.020) ***	23.242 (0.000) ***	2.196 (0.333)	2.489 (0.288)			$\chi^2(3) = 7.81$
Long-run weak exogeneity	33.899 (0.000) ***	37.100 (0.000) ***	9.792 (0.020) ***	55.247 (0.000) ***	38.891 (0.000) ***			$\chi^2(2) = 7.81$

Notes: rph_t—Slovenian hospitality industry prices, rp_t—Slovenian consumer prices, $rfbp_t$—Slovenian food and beverages prices, $dpea_{t-1}$—consumer prices in the Eurozone, and $dphea_{t-1}$—prices in the hospitality industry in the Eurozone, and C—constant. Significance levels p-value in the brackets: *** 1% level of significance.

If variable i is stationary around a constant mean value with a D_s109_t, then one of the cointegration relations must be given by a linear combination of variable i, the constant term and the level shift. When testing for stationarity of variable i we restrict one of the cointegration relations to variable i, the constant term and the level shift, while we leave the other cointegration relations unrestricted. For $r = 3$ we restrict one relation while keeping the other unrestricted. For a rank of $r = 3$, the tests given from CATS for RATS are equal to the manually calculated tests. For $r = 2$ (and $r = 1$), none of the variables are stationary by themselves.

Note that the choice of the cointegration rank matters for the stationarity of the single variables. For $r = 3$ the $dpea_{t-1}$ and the $dphea_{t-1}$, they become borderline stationery, which means that a linear combination of them can give the third cointegration relation $dpea_{t-1}$ and the $dphea_{t-1}$ with the constant term and the level shift. The significance level is: 0.333 for the $dpea_{t-1}$ and 0.288 for the $dphea_{t-1}$, when $r = 2$. The result can be seen in the second raw in Table 3.

4.2.2. Test of Weak Exogeneity

We want to impose a test of a long-run weak exogeneity, as presented in the third row in Table 3. A variable is weakly exogenous for the long-run parameters if the variable is not adjusting to the long-run equilibrium error given by the cointegration relations. A weak exogeneity means that the variable has a zero-row in alpha so that the variable does not react to beta. A zero-row in alpha corresponds to a unit vector in alpha orthogonal. Alpha orthogonal defines the ordinary stochastic trends in the model. The weakly exogenous variable determines the endogenous one by pushing the effects out of equilibrium, and therefore the ordinary stochastic trend is involved in one variable in the opposite direction.

We look at the evidence of a weak exogeneity in Table 3. We can note that all variables react to almost all the other variables. We can thus accept the joint hypothesis of the non-weakly exogenous test. All variables have a p-value of at least 0.020 already when $r = 2$.

4.2.3. Long-Run Cointegration Relations and Restrictions on β

The restrictions based on the previous theoretical scenario are imposed. The nineteen over-identifying restrictions held stationarity and were tested using the likelihood ratio (LR) test procedure parameterised in Johansen and Juselius (1994). The restrictions were accepted with a p-value of 0.732. The restrictions are formulated in an econometric approach with a path where all β coefficients are statistically and empirically correct.

The first long run cointegration vector (CI_a) is:

$$dpea_{t-1} = -0.004 \cdot rph_t + 0.397 \cdot dphea_{t-1} - 0.002 + \epsilon_t, \tag{25}$$

and is normalised by restrictions on β on the real consumer prices in the Eurozone. They are negatively related to the real Slovenian hospitality industry prices, representing a small but statistically significant effect of the national sector economy on the expected inflation in the Eurozone, and positively related to the real prices in the hospitality industry in the Eurozone, respectively. The constant term shows that consumer prices in the Eurozone declined.

The second long run cointegration vector (CI_c) is:

$$dphea_{t-1} = 0.005 \cdot rfbp_t + 0.866 \cdot dpea_{t-1} - 0.001 \cdot D_s 109_t + \epsilon_t, \tag{26}$$

and is a function of the hospitality industry prices in the Eurozone. The real prices in the hospitality industry in the Eurozone are positively related to the real Slovenian food and beverages prices and real consumer prices in the Eurozone, respectively. The shift dummy is in harmony with a small decrease in real prices in the hospitality industry in the Eurozone following the economic crisis. A confirmation of the stationarity of the shift dummy is imposed, and the result is consistent with some recent findings (Juselius 2022; Gričar and Bojnec 2019).

4.2.4. The Cointegrated VAR Model in the Short Run: Empirical Results

In a dynamic equilibrium error correction or CVAR model (Juselius 2009), the non-significant lagged variables are removed from the system based on the calculated and confirmed cointegration relationships. This procedure is determined using the F-test, with insignificant coefficients extracted using the LR test.

Except for a negative correlation between the $dpea_{t-1}$ and $rfbp_t$ (-0.41) shocks, the remaining cross-correlations are essentially more or less zero. The column headline in the top half of Table 4 denotes the dependent variable. The row headings indicate the shape variables. The estimated coefficients of the included dummy variables are also reported in Table 4.

Table 4 can be seen as a statistically significant impact on $dphea_{t-1}$ in the short term. First, impacts on $dphea_{t-1}$ are long-term cointegration vectors CI_a and CI_c. Secondly, we also find an enormously significant relationship between the season's dummies and $dphea_{t-1}$. Several permanent dummies are also significant such as January 2002, October 2004, and September 2009. We can conclude that prices in the hospitality industry in the Eurozone declined in almost all circumstances. The decline is by seasonal effects, cointegration relations, and consumer prices in the Eurozone. They increase only before and after the high season, e.g., June and September.

The empirical results validate the existence of a valid long-run cointegration relationship with short-run parameter constancy. The direct implication of our results is that the short-run model is robust only if the long-run cointegration parameters are included in the model. These findings are vital to a short-run model specification, including different assumptions about whether time-series variable(s) is/are contemporaneously exogenous. The inclusion of the Eurozone and Slovenian hospitality industry prices in the analysis is the correct specification given the tremendous impact of seasonal short-run effects on tourism prices, and therefore, forecasting them as presented in Appendix E.

Table 4. Short-term effects on the hospitality industry prices in the Eurozone.

Variable	$Y_t = dphea_{t-1}$
$dpea_{t-1}$,	−0.13 (−2.63) ***
$rfbp_t$,	0.02 (1.42) *
CIa	−1.18 (−9.37) ***
CIc	−1.50 (−12.6) ***
dum0201p	−0.002 (−1.94) **
dum0709p	0.003 (1.94) **
dum0410p	0.01 (3.28) ***
Δsd $_{\text{January}}$	−0.006 (−7.98) ***
Δsd $_{\text{February}}$	−0.007 (−7.84) ***
Δsd $_{\text{March}}$	−0.006 (−7.57) ***
Δsd $_{\text{April}}$	−0.008 (−9.49) ***
Δsd $_{\text{May}}$	−0.006 (−7.39) ***
Δsd $_{\text{June}}$	0.001 (1.69) *
Δsd $_{\text{July}}$	−0.006 (−4.70) ***
Δsd $_{\text{August}}$	−0.018 (−23.0) ***
Δsd $_{\text{September}}$	0.01 (−11.5) ***
Δsd $_{\text{October}}$	−0.013 (−19.8) ***
Δsd $_{\text{November}}$	−0.014 (−11.7) ***

Notes: $dphea_{t-1}$—prices in the hospitality industry in the Eurozone, $dpea_{t-1}$—consumer prices in the Eurozone, $rfbp_t$—Slovenian food and beverages prices, sd—seasonal dummy; dum0201p, dum0410p, dum0709p, dum0410p—permanent dummies, CI_a and CI_c—cointegration relations. p-value in the brackets: * 10%, ** 5%, and *** 1% level of significance.

Our empirical findings on the short-run effects on tourism prices have additional noteworthy implications for empirical economics and modelling in tourism, adopting new modelling shreds of evidence. The differences in the implementation of tourism modelling in our study shed some light on how the performance of correct variables and statistical models affect the short-run effects. The main benefits of short-run model results of tourism prices include: first, moderation of the level and volatility of prices and inflation; second, analysing the structural breaks in business cycles; and third, following the misspecification test are exclusion test, rank test and test of restrictions on β.

This time-series data research could be extended to more countries using the euro as a national currency. Such extended time-series data research would represent the studied determined impact of a specific country on the hospitality industry prices in the Eurozone and consumer prices in the Eurozone. From the methodological point of view, the research can be extended to Granger causality between the variables as presented in Table A2, Appendix G.

5. Discussion

We have critically evaluated the simple static regression analysis approach in the literature, which is often used to analyse time-series data. We have also presented non-stationarity with unit roots and stochastic trends/shocks. Instead of simple static regression analysis, we apply the CVAR model to analyse time-series data for tourism prices. This is a novelty and a contribution to the theoretical literature.

We first tested the time-series properties of each variable and restrictions in the VAR model. The nominal time series prices are integrated with order two, and the VAR model includes a linear transformation of the tourism prices and inflation variables. We reformulated the VAR model with the transformed variables without losing information when the restrictions were imposed. Therefore, we decided to use variables of order one.

The formal misspecification tests confirmed that the VAR model does not contain autocorrelations or heteroskedasticity in the residuals. Normality tests based on skewness and kurtosis are used to check the integrity of the standard residuals of the model and variables. Normality tests based on skewness and kurtosis are used to check the integrity of the standard residuals of the model and the variables. As part of this process, the stability of the VAR model was developed, and the propositional condition of the different dummies should be included.

The unrestricted VAR model has two lags and a rank of three; the eigenvalues are derived using the trace or Johansen test. In the restricted VAR model, there are non-weak exogenous variables. In this sense, all five time series data are endogenous variables. We apply a test for the short-run cointegrated VAR (CVAR) model. We can find that prices in the hospitality sector in the euro area have fallen in almost all circumstances. The decrease is due to seasonal effects, except in June and September when they increase due to long-run cointegration relationships and consumer prices in the Eurozone.

The long-run cointegration relationship normalised to β-coefficients for the hospitality prices in Slovenia was not found. Moreover, the test of long-run exclusion and the results of the combined effects of the Π-matrix suggest that the Slovenian hospitality prices should be removed from the CVAR model. This conclusion confirms the research objectives for the economic modelling literature: simple regression analyses cannot be performed for dynamic time series models where the Slovenian hospitality prices are a significant dependent variable. We point out that a long-run cointegration relationship in modelling short-run effects of "nominal to real" prices is necessary as robust evidence for analysing tourism price trends.

6. Conclusions

This study defined a state-of-the-art empirical model on general and sectoral prices in Slovenia and the Eurozone. The main objective was to build a theoretical model and test the robustness of the econometric model. Since prices explore high volatility, the primary purpose was to investigate volatility and perform an objective CVAR modelling procedure as a technical step for reliable modelling and prediction.

The importance of inflation in the econometric procedures was primarily discussed by Juselius (2009); therefore, this research fills the gap in the literature by showing the time series conformances. The volatility of prices was identified and confirmed. The normalities on the residuals were challenging to obtain and led to several findings:

- essential step: the nominal to a real transformation of the variables;
- the definition of the econometric model: several deterministic coefficients needed;
- a guarantee of the corresponding cointegration rank with a slight lag difference;
- and defining cointegration vectors and relations of the short-run effects on tourism prices.

The theoretical importance of the study is reflected in the technical procedure that must be carried out before applying the model to an empirical sample. The empirical implication is defined in a reliable empirical model based on econometric steps that can subsequently predict the future dispersion of the data, which is presented in Appendices B–D and F. The outlook on these results shows that the model has high conformance for the first 48 months, while only a few outliers were detected. Nonetheless, in the last period of the sample, some more substantial downward fluctuations in consumer price indexes and the food and beverage index were observed. This striking result could also explain the increase in prices in the following periods up to the present.

Overall, the study has some limitations as possible issues for research in the future:

- the data have not been deseasonalized. This decision is based on extracting as much as possible from the raw data;
- the sample period is limited to the most severe period of the 2008 economic crisis.

In summary, this study has added an essential scientific and technical step to the definition of econometric modelling of time series using aggregate values, leading to a big data adventure in future phases. However, in the appendices, one can find the benchmark models for predictive modelling of cointegrated behaviour of time series in tourism, which has been primarily omitted in tourism research. Therefore, this research adds value to management policy analysis for decision-making and economic theory at the integration level to obtain the most appropriate and meaningful forecasts and models for tourism pricing.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Misspecification test of real price indices for the in-sample.

Miss–Variables	$\boldsymbol{rph_t}$	$\boldsymbol{rp_t}$	$\boldsymbol{rfbp_t}$	$\boldsymbol{dpea_{t-1}}$	$\boldsymbol{dphea_{t-1}}$
Transformation procedure	$(rph_t^r = log(\frac{IPHI_t}{IPHIEA_t}))$	$(rp_t^r = log(\frac{CPI_t}{CPIEA_t}))$	$(rfbp_t^r = log(\frac{IFB_t}{IPHIEA_t}))$	$(dpea_{t-1} = log(\frac{CPIEA_t}{CPIEA_{t-1}}))$	$(dphea_{t-1} = log(\frac{IPHIEA_t}{IPHIEA_{t-1}}))$
Skewness	0.350	−0.081	−0.209	0.120	−0.140
Kurtosis	2.958	2.438	3.628	3.274	3.274
ARCH test	$1.275^{(0.529)}$	$4.591^{(0.101)}$	$0.015^{(0.992)}$	$6.005^{(0.05)}$	$0.696^{(0.706)}$
Normality test	$3.399^{(0.183)}$	$1.860^{(0.394)}$	$4.140^{(0.126)}$	$1.531^{(0.465)}$	$1.597^{(0.450)}$
R^2	0.894	0.528	0.715	0.862	0.977
Model					
Trace or rank test					r = 3
ARCH test			(1): $207.211^{(0.797)}$ (2): $462.989^{(0.326)}$		
Normality test			$11.570^{(0.315)}$		
Number of lags					$p = 2$
LM test			(1): $22.767^{(0.591)}$ (2): $30.705^{(0.199)}$		

Note. rph_t—Slovenian price index in the hospitality industry, rp_t—consumer price index in Slovenia, $rfbp_t$—Slovenian food and beverages price index, $dpea_{t-1}$—consumer price index in the Eurozone, $dphea_{t-1}$—Eurozone price index in the hospitality industry. Significance levels p-value in the brackets, R^2—adjusted deterministic coefficient, r—(nominal to) real, d—differenced variable.

Appendix B

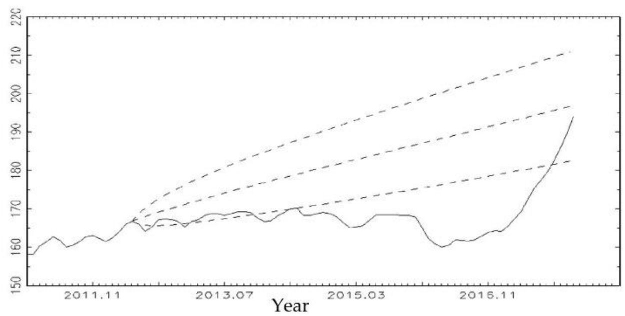

Figure A1. Time series forecasting for CPI, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017 (horizon of 67 months), base month January 2000 = 100.

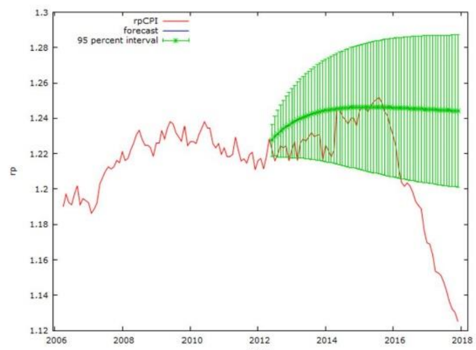

Figure A2. Time series forecasting for rp, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017 (horizon of 67 months), base month January 2000 = 100.

Appendix C

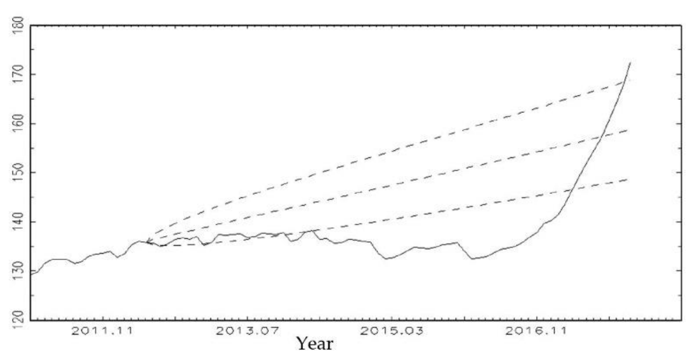

Figure A3. Time series forecasting for CPIEA, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

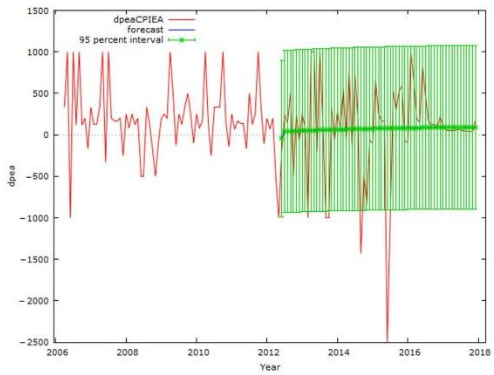

Figure A4. Time series forecasting for dpea, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

Appendix D

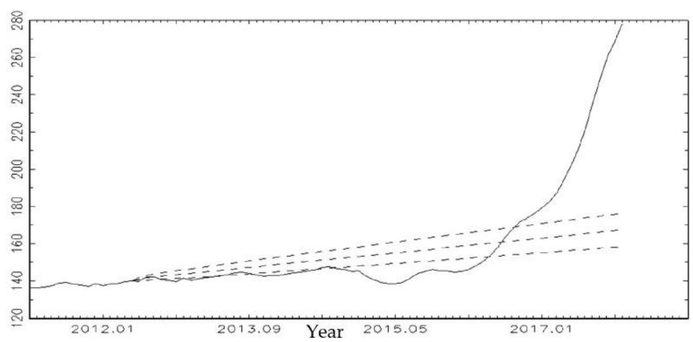

Figure A5. Time series forecasting for IPHIEA, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

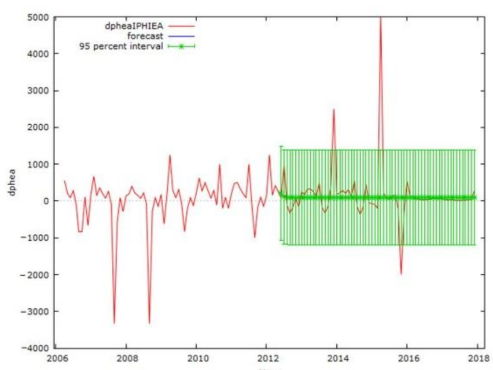

Figure A6. Time series forecasting for dphea, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

Appendix E

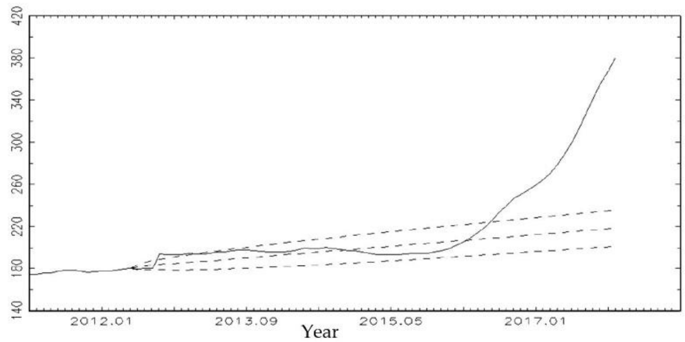

Figure A7. Time series forecasting for IPHI, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

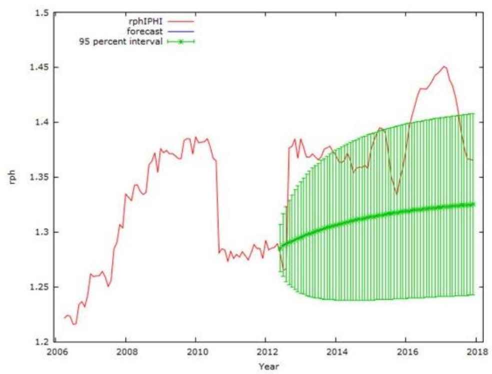

Figure A8. Time series forecasting for rph, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

Appendix F

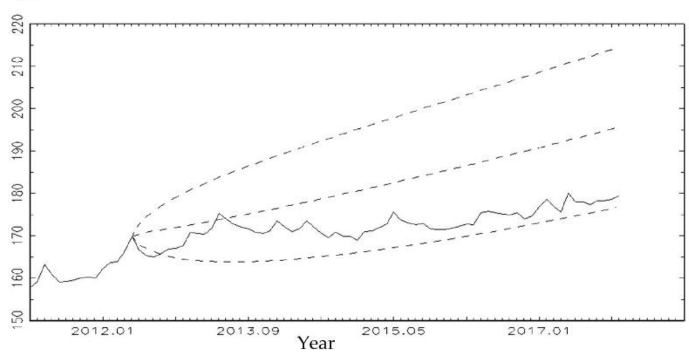

Figure A9. Time series forecasting in VAR model for IFB, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

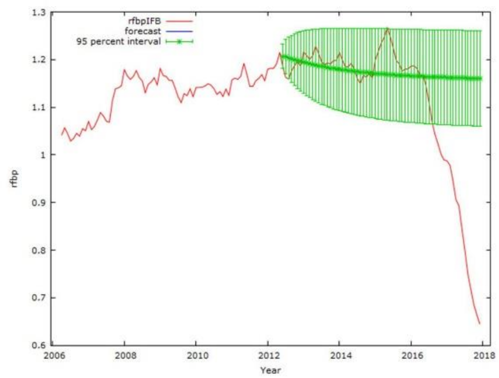

Figure A10. Time series forecasting in VAR model for rfbp, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

Appendix G

Table A2. Granger Causalities.

The Way of Causality *	F-Statistics	Decision	p-Value
$rfbp \leftrightarrow rp$	2.73 (7.86)	Bi-causality	0.00 (0.06)
$rfbp \rightarrow dpea$	5.25	Uni-causality	0.01
$dphea \rightarrow rfbp$	3.16	Uni-causality	0.05
$rfbp \rightarrow dpea$	5.25	Uni-causality	0.01
$rp \leftrightarrow dpea$	5.00 (2.33)	Uni-causality	0.01 (0.10)

* Only significant relations are presented.

Appendix H

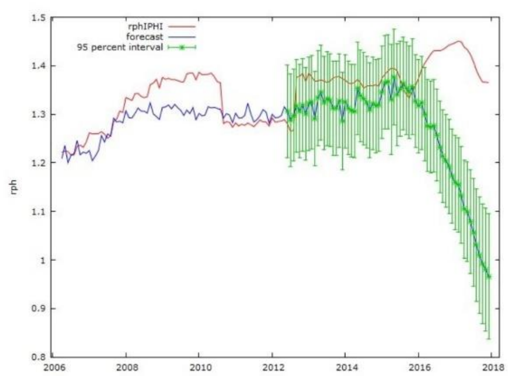

Figure A11. Time series forecasting in OLS for all variables, rph is a dependent variable, the in-sample January 2000–May 2012, and the out-of-sample June 2012–December 2017, base month January 2000 = 100.

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