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Assessing the COVID-19 pandemic impact on tourism arrivals: The role of innovation to reshape the future work for sustainable development

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ABSTRACT

The current COVID-19 pandemic has generated unprecedented disruption in the tourism sector, requiring innovative solutions to reshape future work for sustainability. Despite the several benefits of tourism and innovation, studies examining the interlinkages among tourism, pandemic uncertainty, and innovations for sustainability are rare. To fill this gap, this paper investigates the impact of the pandemic on tourism arrivals, and the effects of tourism arrivals and pandemic impacts on the sustainable development of France. The paper further considers the innovation influences on pandemic uncertainty to consider it key for the control of the pandemic. Autoregressive distributed lag results based on 25 years of historical data show that the immediate effects of pandemic discussion on tourism arrivals are insignificant. However, in the long run, such effects become significantly negative, revealing that a rise in pandemic discussion reduces tourism arrivals in France. We find that tourism arrivals and pandemic discussions have positive significant effects on the sustainability of France. The tourism arrivals and pandemic discussion interaction results reveal that tourists who are aware of the pandemic significantly contribute to sustainability. Significant evidence shows that a rise in innovation helps to reduce pandemic uncertainty. However, innovation's short-term effects are more prominent compared with the long-term effects, indicating that the pandemic can be countered in the short run with the help of innovative solutions. Thus, relying on innovation, especially innovations related to COVID-19 will reduce the pandemic's risk. Our results were robust to various econometric methodologies. We have drawn policy implications to focus on tourism development and constant innovations for sustainable recovery.

Introduction

Sustainability has become an important point of discussion and communication (Kim, Hall & Han, 2021). The 2015 United Nations global goals (SDGs) for 2030 emphasized peace and prosperity for all. Sustainability can be influenced by several uncertain factors, such as environmental degradation or the current global COVID-19 pandemic. The World Health Organization (WHO) has announced COVID-19 as a pandemic (i.e., a global disease). To monitor and control the pandemic, the focus has been given to minimizing the mobility of people, such as discouraging gatherings, and closing restaurants and industries. Limitations of visa approval and flight suspensions have been common for travelers (Kiernan & De Vita, 2020). As a result, most organizations, especially small and medium enterprises, have been struggling to survive (Lee & Trimi, 2021). The objectives of this article are threefold: 1) to estimate the pandemic's impacts on the tourism arrivals in France; 2) to estimate the tourism and pandemic impacts on the sustainable development of France; and 3) to estimate innovations' effect on the pandemic, which are equally important for policies. Understanding the pandemic's influence on tourism and sustainability will help in tourism recovery. It will determine if the initial pandemic restrictions are helpful in sustainability. If so, there will be opportunities for improvement in the long run with the strategies that are helpful in the sustainability of France. Estimating the effects of innovations on the pandemic is equally important to guide how innovations and digital solutions help to control the outspread of the pandemic. Overall, measuring the impacts of the pandemic on tourism and sustainability and innovations' effects on the pandemic are important for future work and

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this paper will trace out the linkages based on French historical data of 25 years.

The COVID-19 pandemic has affected the tourism sector considerably as every effort to control the pandemic is directly linked to tourism and travel. Its reason might be the fact that travel and tourism can be critical carrying vectors of disease. The tourism sector is important for growth and development, and in 2019, this sector has a 10.4% contribution to global GDP. Yang et al. (2021) commented that media coverage related to COVID-19 information negatively influences potential visitors' behavior. Similarly, Hall, Fieger, Prayag and Dyason (2021) viewed fear and insecurity as the key response to the disaster. Zheng, Luo and Ritchie (2021) reported that COVID-19 has generated public distress. Furthermore, past experiences show that the tourism industry always face challenges because of uncertainties and crises with slow recovery (Novelli, Burgess, Jones & Ritchie, 2018). For example, in 2003, during the outbreak of SARS, nearly 3 million tourism employees worldwide lost their jobs, with an economic loss of 20 billion only in East Asia.

France has been recognized as the seventh-largest power in the world and has suffered heavy growth contractions due to the COVID-19 pandemic. IMF reports France's GDP growth contracted by −19% in the second quarter of 2020, and the overall decline in 2020 was −8.2%. Tourism generates 180-billion-euro revenues in France, where around 60 billion euros are from international tourism. The immediate impact of COVID-19 goes with the loss of at least 30–40 billion euros from summer tourists (York, 2020). Similarly, WTTC data confirm that the loss can be as high as 48 billion euros (WTTC, 2020). Domestic consumption, which is the main driver of the economy, has fallen by 11%, while 57% of hotel and restaurant business declines have been observed during the fourth quarter of 2020 (France24, 2020). Tourist operators continue to lose their jobs at a high rate, and their income drops by 20%–25% within a year, while some have closed their businesses due to unemployment.

In view of the devasting impact of the pandemic on various sectors of the French economy, and especially on the tourism sector, this paper aims to estimate the impact of the pandemic on tourism arrivals and on the sustainable development of France, as well as measure the effects of innovations on the pandemic, which is equally important for reshaping future works and policies. This study answers the following research questions. RQ1: How does the pandemic affect French tourism arrivals? RQ2: How do pandemic and tourism development influence French sustainability? RQ3: How do innovations help to reduce future pandemic risk and reshape future works for sustainable development?

Our study makes three fundamental contributions to the field. First, this paper estimates the influence of pandemic discussion on tourism arrivals in France as tourism is among the main growth pillars of the economy. Thus, understanding how the pandemic affects tourism arrivals is important. Second, the paper investigates the effects of tourism arrivals and the pandemic on the sustainable development of France. Sustainable development is more important than GDP growth, because in sustainability, we are not only concerned with ourselves by compromising on the environment, but we also want to leave this beautiful world for future generations to have healthy lifestyles. Third, we estimate the effects of innovations on the pandemic to determine if innovations can help to reduce the risk of the pandemic and if innovative digital solutions can help to reshape future works for sustainability. We utilize the pandemic discussion data recently introduced by Ahir, Bloom and Furceri (2021). The pandemic discussion index shows the percent of pandemic-related words in Economist Intelligence Unit (EIU) reports, with the multiplication of 1000 where keywords (i.e., "severe acute respiratory syndrome," "Coronavirus," "COVID-19," "Middle East respiratory syndrome," "SARS," "Ebola," "H1N1," "H5N1," "World Health Organization," "WHO," "avian flu," "MERS (Middle East respiratory syndrome)", "bird flu," "H1V1," "influenza," and "swine flu") are incorporated in the construction of the pandemic index. A higher number indicates a higher discussion on the pandemic and vice versa.

This paper employs the autoregressive distributed lag (ARDL) to cointegration method by Pesaran et al. (2001), considering its advantages such as its better performance in short-spanned data. ARDL makes it less important to investigate the variables' unit root testing properties. In addition, it overcomes endogeneity issues efficiently by introducing lags in the system to make the model dynamic (Pesaran et al., 2001; Ahmad et al., 2017). The paper also considers fully modified ordinary least squares (FMOLS) and dynamic ordinary least square (DOLS) as alternative methods to extract long-term coefficient estimates. FMOLS and DOLS perform well in small sample sizes, and they can overcome endogeneity and serial correlation issues by introducing leads and lags in the model (Phillips & Hansen, 1990; Stock & Watson, 1993). ARDL, FMOLS, and DOLS can explain the long-term cointegration among variables and guide the signs of the coefficients of independent variables. However, these methods cannot explain the direction of causal relationships among the variables. Thus, this paper adopts the Granger causality test to detect causal relationships among variables. Granger causality is a system hypothesis that detects if one series can be used to predict another (Wei, 2016).

The remainder of this paper is organized as follows. Section 2 discusses the literature review. Section 3 presents the research design. Section 4 presents the results and discussion. Finally, Section 5 concludes the paper with policy suggestions.

Brief literature review

In this article, we extend the pandemic, tourism, innovation, and sustainable development debate to investigate the impact of the pandemic on tourism arrivals and on sustainable development, as well as the effects of innovations on the pandemic. The following is an overview of the ideas of former research to strengthen the idea of the current work. Despite the fact that no study has been conducted to investigate the relationship among pandemic, tourism, sustainability, and innovation, particularly in France, recent studies have extended our understanding by exploring the nexuses between economic policy uncertainties and economic activities (Xu, 2020; Sharma & Reddy, 2021). Unfortunately, pandemic has no exact definition; a pandemic can be defined as a disease that spreads widely by crossing countries, borders, and continental boundaries. Thus, a pandemic generates more public fear and panic considering its intensity and serious threats. Zhang et al. (2022) documented that tourism is closely related to information science; especially considering pandemic threats and fear, people are preferring virtual tourism.

On the other side, carbon emissions have significantly dropped during the COVID-19 pandemic; thus, overall, the environmental situation improved during this short period. The reason might be the fact that during the pandemic, businesses and industrial activities are fewer; as a result, the environmental situation has initially improved overall. For example, during the pandemic, people do not prefer to use buses and cars; rather, cycling is on rise to avoid crowds, which has improved the environment. Zheng, Luo and Ritchie (2021) expressed that during the pandemic, governments have normally implemented some restrictions on travel, social gatherings, schools, and hotels, which all add to public fear. The United Nations (2021) reported an 84% decline in international tourism globally between March and December 2020, and overall, 88% of global tourism declined.

During the pandemic, governments have adopted several precautionary measures to control the spread of the virus, which has further created public fear (Eichelberger, 2007). Fung et al. (2014) reported that pandemic fear can be increased by observing others' reactions where social media and online news fuel the fear. Athari, Kirikkaleli and Adebayo (2022) examined the influence of world pandemic

uncertainty on the German stock market index, and their findings showed that the world pandemic uncertainty negatively affected the German stock market, revealing its adverse effects. Researchers such as Yang, Zhang and Chen (2020) have introduced a DSGE model to investigate the impact of the pandemic on tourism. Karabulut et al. (2020) investigated the influence of pandemic discussion on tourist arrivals and confirmed that the pandemic discourages tourism arrivals. Zheng, Luo and Ritchie (2021) commented that the COVID-19 pandemic has generated public fear, and it will thus take time to return to normal; moreover, even if the pandemic is over soon (as is expected), it will have a lasting impacts on tourism, considering that public fear and recovery time. Ahmad, Liu and Hdia (2022) documented that tourism development is important for sustainability. By taking the example of G7 economies, they showed that tourism development helps to raise economic growth and improves environmental quality.

Bhutto et al. (2021) discussed green innovation and sustainability, considering tourism as an important commercial activity. By analyzing the data of 302 employees in the tourism and hospitality sector, they concluded that green inclusive leadership and green work engagement are positively related to green creativity. Serravalle et al. (2019) documented that digitalization can help us to focus on the opportunities offered by technological innovations, as digital models can facilitate business models to boost the tourism industry, highlighting the importance of innovative technologies for visitors. Ferraris et al. (2021) empirically investigated the interrelation among creative partnerships, knowledge application capacities, and innovation performance in food companies, and concluded that creative partnerships are important for innovation in food industries. Similarly, Bresciani et al. (2021) shed light on the devasting impacts of the COVID-19 pandemic on different types of accommodation, and concluded that travelers are hesitant to book shared flats during the pandemic, revealing the travelers' fear. They verified that full flats are travelers' preferred choice during the pandemic, highlighting the need for physical distance. In the same line, Bouncken, Kraus and Ancillo (2022) commented that the world has been shaken by the global crisis with the severe implications for organizations and firms. Overall, such studies have highlighted that the pandemic has created public fear and people are reluctant to travel. In this regard, smart use of technology can help reduce the pandemic risk, which will further boost the economy's growth and development process (Cantino et al., 2019).

Madanaguli, Kaur, Mazzoleni and Dhir (2021a) considered entrepreneurship as the key element for rural tourism development and sustainability. They conducted a systematic review for the period of 2000–2020 and showed that the hospitality and tourism sector in rural areas has received limited attention from the entrepreneurship perspective. Their study further encourages focusing on this key direction and requires innovations in rural tourism (Madanaguli, Kaur, Mazzoleni & Dhir, 2021b), such that this sector can better contribute to sustainable development. Madanaguli, Srivastava, Ferraris and Dhir (2022) also highlighted the importance of corporate social responsibility and sustainable tourism. A systematic literature review has shown the importance of corporate social responsibility in the tourism sector. Athari et al. (2021a) examined the determinants of tourism to investigate the effects of political risk, economic growth, exchange rate, and inflation rate on inbound international tourists. They observed a negative influence of the exchange rate and a positive effect of inflation on tourism arrivals. Economic growth also has a positive influence on tourism arrivals, revealing the validity of the tourism-led growth hypothesis. (Kraus et al., 2020) highlighted the issue of the COVID-19 pandemic in family firms by marking it as a new type of challenge for humanity, as the pandemic has not only caused deaths but put a series of restrictions on daily lives and businesses. Athari et al. (2021b) investigated the effects of domestic economic, political, and financial risks on tourism development. They used GMM for the panel data of 73 countries from 2006 to 2017 and found that reducing economic, political, and financial risks can improve tourism development.

Lee and Chen (2011) reported that tourism is a sensitive industry and that negative publicity around tourist spots often result in a decline in tourism arrivals. The tourism industry relies on the mobility of people, and the recent COVID-19 pandemic has had a significant impact on this industry (Salem et al., 2021; Nicola et al., 2020). Not surprisingly, the WTTC (2020) found that around 75 million jobs are at risk because of the pandemic, whereas human capital in the tourism industry is important to support economic development. Furthermore, digital solutions, such as electronic platforms, can help in meetings and monitoring to keep the tourism industry on track until the pandemic intensity declined to start with tourism and travel. Wen et al. (2020) documented that diseases such as the COVID-19 pandemic have stopped and slowed down tourism and travel, as this industry requires frequent human contacts. The authors showed an agreement that digital solutions can keep the tourism industry alive. In sum, the COVID-19 pandemic has paralyzed the tourism sector (Hoque et al., 2020), where planes are on the grounds and hotels are closed (García-Milon et al., 2021). Researchers such as Zenker and Kock (2020) have commented that the COVID-19 pandemic and tourism-related research are at its infancy stage. We agree with this by proposing straightforward models to investigate the pandemic's impact on tourism arrivals and on the sustainability of France. We also consider the role of innovations to control the outspread of a pandemic, which will further help to reshape future works for sustainability.

Overall, the above literature has given us the confidence to report that uncertainties such as pandemics affect tourism arrivals and sustainable development, although no empirical study has investigated the linkages among pandemics, tourism arrivals, and sustainable development in France. In addition, innovations have played a key role in controlling the pandemic and keeping businesses alive. Thus, understanding the influence of innovation on pandemics is also equally important. This study fills the knowledge gap by investigating the impact of the pandemic on tourism arrivals and sustainable development, as well as the influences of innovations on pandemic uncertainties. In doing so, we will be able to answer some important questions, such as how the pandemic influences tourism arrival behavior, how tourism arrivals and the pandemic affect the sustainable development of France, and how innovations help to control the outspread of a pandemic (if any). Specifically, we use France's case because its growth and development are heavily influenced by the tourism industry. Moreover, we use robust econometrics techniques to extract results. Hence, the findings of the study are important for policy and practical implications.

Research design

Data

We collected data sets from different authentic reliable data sources and measured each variable's proxy based on existing literature and theory. Pandemic data is pandemic discussion-related data showing how pandemic-related words appear in the EIU, as recently introduced by Ahir et al. (2021). The pandemic discussion index shows the percent of pandemic-related words in the EIU, with the multiplication of 1000 where certain keywords ("severe acute respiratory Syndrome," "Coronavirus," "COVID-19," "Middle East respiratory syndrome," "SARS," "Ebola," "H1N1," "H5N1," "World Health Organization," "WHO," "avian flu," "MERS (Middle East respiratory syndrome)," "bird flu," "H1V1," "influenza," and "swine flu") have been utilized to construct the index. A higher number indicates a higher discussion on the pandemic, and vice versa. The total number of international arrivals represent the tourism arrivals (Ahmad & Ma,

Table 1
Variable description and sources.

Variable	Description/measurement	Symbol	Source
Tourism arrivals	Total number of international arrivals	TR	World development indicators, World Bank (2021)
Pandemic discussion	Pandemic discussion-related words appeared in Economics Intelligence unit (EIU)	PD	Ahir et al. (2021)
Sustainable development	Adjusted net savings, excluding particulate emission damage (% of GNI)	ANS	World development indicators, World Bank (2021)
Real GDP	GDP per capita (constant 2010 US$)	GDP	World development indicators, World Bank (2021)
Foreign direct investment	Foreign direct investment, net inflows (% of GDP)	FDI	World development indicators, World Bank (2021)
Stock of capital	Gross fixed capital formation (it is the percentage of annual growth)	K	World development indicators, World Bank (2021)
Energy consumption	Energy use is the kg of oil equivalent per capita	E	World development indicators, World Bank (2021)
Urban population	Total urban population living in urban areas	URB	World development indicators, World Bank (2021)
Technological Innovation	Patent applications, residents	INOV	World development indicators, World Bank (2021)
Hospital beds	Hospital beds ((per 1000 people)	HB	World development indicators, World Bank (2021)

2021; Karabulut et al., 2020). It counts the total tourists' entry by air and land to a new country, with the main purpose of recreational activities. The adjusted net savings, excluding particulate emission damage (% of GNI), were used as a reliable proxy of sustainable development, as measured by the World Bank. Innovation was measured by the total number of patent applications by the residents of the country (Ahmad, Liu & Hdia, 2022).

In addition to the main variables, we considered additional control variables based on economic theory to overcome omitted variable bias in our analyses. The GDP per capita (constant 2010 US$) was used to represent economic development. Other variables were foreign direct investment; net inflows (% of GDP), which represent foreign investment; gross fixed capital formation which is the percentage of annual growth) for stock of capital; energy use (kg of oil equivalent per capita) for energy consumption; urban population, which is the total population living in urban areas; and hospital beds per 1000 people. Additional variables often support overcoming omitted variable bias, as well as additional policy suggestions. All data (except the pandemic discussion from Ahir et al. (2021)) were from world development indicators, World Bank, which is a highly reliable data source. Table 1 shows the detailed description, definitions, and data sources of the variables. The time period of 1996 −2020 was based on pandemic discussion data availability. The missing values were extrapolated using an average method. The variables were transformed in log form to overcome data fluctuations. The stock of capital was without log form, as negative values were present in the data and no heavy fluctuations was observed that require smoothness (Ahmad & Du., 2017). Thus, the stock of capital interpretation would be in units, whereas the rest would be in percentages.

Models

Inspired by Karabulut et al. (2020), Ahmad and Ma (2021), and Santana-Gallego et al. (2020), we constructed our model to answer how the pandemic influences tourism arrivals. The pandemic was considered the main independent variable, and tourism arrivals as the dependent variable. Economic growth, domestic and foreign capitals, and urban population were included to make additional notes and overcome omitted variable bias in the analysis.

The first model is constructed as follows:

$$TR_t = \alpha_0 + \beta_1 PD_t + \beta_2 GDP + \beta_3 FDI_t + \beta_4 K_t + \beta_5 URB_t + \varepsilon_t \quad (1)$$

where *TR* denotes the tourism arrivals, *PD* represents the pandemic discussion, *GDP* is the real GDP per capita, *FDI* is the foreign direct investment, *K* is the stock of capital, *URB* is the urban population, *t* denotes time, α_0 is a constant, ε is a white noise error term, B_1 is the coefficient of the pandemic, B_2 is the coefficient of the real GDP per capita, B_3 is the coefficient of *FDI*, B_4 is the stock of capital coefficient, and B_5 is the coefficient of urban population.

Inspired by Ahmad, Liu and Hdia (2022), we constructed the second model to test the pandemic and tourism arrivals' effects on the sustainable development of France. We considered control variables, such as foreign direct investment, energy consumption, and urban population, to counter the omitted variable bias in the analysis. The model is as:

$$ANS_t = \delta_0 + \delta_1 TR_t + \delta_2 PD_t + \delta_3 FDI_t + \delta_4 E_t + \delta_5 URB_t + \varepsilon_t \quad (2)$$

where *ANS* denotes the sustainable development, *TR* represents the tourism arrivals, *PD* represents the pandemic discussion, *FDI* is the foreign investment, *E* is the energy consumption, *URB* is the urban population, *t* denotes time, ε is the white noise error term, and $\delta_1 - \delta_5$ are the coefficients of respective variables.

We considered the third model with the interaction of tourism arrivals and pandemic discussion to investigate the influence of the interaction on the sustainable development of France. In other words, these are those tourists who are aware of the pandemic. Thus, understanding the interaction of tourism and the influence of pandemic discussion on the sustainable development of France is equally important.

The third model is as:

$$ANS_t = \delta_0 + \delta_1 TR_t + \delta_2 TRPD_t + \delta_3 FDI_t + \delta_4 K_t + \delta_5 E_t + \delta_6 URB_t + \varepsilon_t \quad (3)$$

where *ANS* is the sustainable development, *TR* is the tourism arrivals, TR*PD* is the tourism arrivals*pandemic discussion (interaction of tourism arrivals and pandemic), *FDI* is the foreign investment, *K* is the stock of capital, *E* is the energy consumption, *URB* is the urban population, *t* is the time, ε is the white noise error term, and $\delta_1 - \delta_6$ are the coefficients of respective variables.

The fourth model was constructed to answer how the pandemic responds to innovations and how the rise in innovations influences the pandemic. We considered tourism development, hospital beds, foreign investment, energy consumption, and urban population as the additional input factors that can possibly influence pandemic uncertainty.

$$PD_t = \delta_0 + \delta_1 INOV_t + \delta_2 TR_t + \delta HB_{3t} + \delta_4 FDI_t + \delta_5 E_t + \delta_6 URB + \varepsilon_t \quad (4)$$

where *PD* is the pandemic, *INOV* is the innovations of the country, *TR* is the tourism arrivals, *HB* is the number of hospital beds, *FDI* is the foreign direct investment, *E* is the energy consumption, *URB* is the urban population, *t* is the time, ε is the white noise error term, and $\delta_1 - \delta_6$ are the coefficients of respective variables that are interpreted in elasticities.

Econometric methodology

We can use various econometric methods in estimating the above four models to show how the pandemic influences tourism arrivals, how tourism arrivals and pandemics influence the sustainable development of France, and how innovations help to counter the pandemic. The methods included those of Engle and Granger (1987), Johansen et al. (1988), and Pesaran et al. (2001). Particularly, the ARDL method (Pesaran et al., 2001) has some advantages over other methods. Engle and Granger's (1987) method is useful for determining the causal relation of two variables (i.e., *Y* is causing *X* or *X* is

causing *Y*). Johansen et al.'s (1988) method is suitable for a large sample, but all variables must follow the *I(1)* unit root condition. In reality, a large sample is difficult to obtain due to the lack of data and the condition of *I(1)* being strict. The ARDL can be used irrespective of the stationary of variables, that is, it can be used if all variables are *I(0)* or *I(1)*, or a mixture of *I(0)* and *I(1)*. Furthermore, it outperforms in a small sample size (Pesaran et al., 2001; Pesaran & Shin, 1999), as well as overcomes endogeneity issues efficiently by introducing lags in the model (Pesaran et al., 2001; Ahmad et al., 2017).

The ARDL to cointegration is a two-step procedure. First, the joint f-statistics were estimated to determine the long-term relationship among variables, with the null hypothesis of no long run. Pesaran et al. (2001) offered two types of critical value, that is, lower- and upper-bound values. The estimated joint f-statistics below the lower-bound values reveal no long-term relationship, whereas the f-statistics above the upper-bound values reveal the long-term cointegration. In the presence of cointegration, we could further estimate the short- and long-run coefficients to interpret them in elasticities.

We applied the ARDL method with the following unrestricted error correction regressions:

$$\begin{aligned}\Delta TR_t = {} & \delta_0 + \sum_{i=1}^{\kappa 1}\delta_{1i}\Delta TR_{t-i} + \sum_{i=0}^{\kappa 2}\delta_{2i}\Delta PD_{t-i} + \sum_{i=0}^{\kappa 3}\delta_{3i}\Delta GDP_{t-i} \\ & + \sum_{i=0}^{\kappa 4}\delta_{4i}\Delta FDI_{t-i} + \sum_{i=0}^{\kappa 5}\delta_{5i}\Delta K_{t-i} + \sum_{i=0}^{\kappa 6}\delta_{6i}\Delta URB_{t-i} \\ & + \beta_1 TR_{t-1} + \beta_2 PD_{t-1} + \beta_3 GDP_{t-1} + \beta_4 FDI_{t-1} \\ & + \beta_5 K_{t-1} + \beta_6 URB_{t-1} + \varepsilon_{1t}\end{aligned} \tag{1.1}$$

$$\begin{aligned}\Delta ANS_t = {} & \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta ANS_{t-i} + \sum_{i=0}^{n2}\beta_{2i}\Delta TR_{t-i} + \sum_{i=0}^{n3}\beta_{3i}\Delta PD_{t-i} \\ & + \sum_{i=0}^{n4}\beta_{4i}\Delta FDI_{t-i} + \sum_{i=0}^{n5}\beta_{5i}\Delta E_{t-i} + \sum_{i=0}^{n6}\beta_{6i}\Delta URB_{t-i} \\ & + \delta_1 ANS_{t-1} + \delta_2 TR_{t-1} + \delta_3 PD_{t-1} + \delta_4 FDI_{t-1} + \delta_5 E_{t-1} \\ & + \delta_6 URB_{t-1} + \varepsilon_{2t}\end{aligned} \tag{2.1}$$

$$\begin{aligned}\Delta ANS_t = {} & \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta ANS_{t-i} + \sum_{i=0}^{n2}\beta_{2i}\Delta TR_{t-i} + \sum_{i=0}^{n3}\beta_{3i}\Delta TRPD_{t-i} \\ & + \sum_{i=0}^{n4}\beta_{4i}\Delta FDI_{t-i} + \sum_{i=0}^{n5}\beta_{5i}\Delta K_{t-i} + \sum_{i=0}^{n6}\beta_{6i}\Delta E_{t-i} + \sum_{i=0}^{n7}\beta_{7i}\Delta URB_{t-i} \\ & + \delta_1 ANS_{t-1} + \delta_2 TR_{t-1} + \delta_3 TRPD_{t-1} + \delta_4 FDI_{t-1} + \delta_5 K_{t-1} + \delta_6 E_{t-1} \\ & + \delta_7 URB_{t-1} + \varepsilon_{3t}\end{aligned} \tag{3.1}$$

$$\begin{aligned}\Delta PD_t = {} & \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta PD_{t-i} + \sum_{i=0}^{n2}\beta_{2i}\Delta INOV_{t-i} + \sum_{i=0}^{n3}\beta_{3i}\Delta TR_{t-i} \\ & + \sum_{i=0}^{n4}\beta_{4i}\Delta HB_{t-i} + \sum_{i=0}^{n5}\beta_{5i}\Delta FDI_{t-i} + \sum_{i=0}^{n6}\beta_{6i}\Delta E_{t-i} + \sum_{i=0}^{n7}\beta_{7i}\Delta URB_{t-i} + \\ & + \delta_1 PD_{t-1} + \delta_2 INOV_{t-1} + \delta_3 TR_{t-1} + \delta_4 HB_{t-1} + \delta_5 FDI_{t-1} + \delta_6 E_{t-1} \\ & + \delta_7 URB_{t-1} + \varepsilon_{4t}\end{aligned} \tag{4.1}$$

In Eq. (1.1), Δ is the difference operator; *t* is the time; ε is the white noise error term; δ_1–δ_6 are the error dynamics; β_1–β_6 are the long-term coefficients of tourism arrivals, pandemic discussion, economic development, foreign investment, stock of capital, and urban population, respectively. In Eq. (2.1), sustainable development is the dependent variable, whereas tourism arrivals and pandemic discussion are the main independent variables, along with foreign direct investment, energy consumption, and urban population. In Equation, 3.1, we introduced the interaction between tourism arrivals and pandemic discussion (TR * PD), which refers to tourists who are aware of the pandemic. The other variables are foreign investment, domestic investment, energy consumption, urban population, and tourism arrivals. Eq. (4.1) represents the influence of innovation on the pandemic, with the control variables of tourism arrivals, hospital beds, foreign investment, energy consumption, and urban population.

Eq. (1.1) was estimated using the OLS method to extract the coefficients, and Wald's test was employed on long-term coefficients to extract the f-statistics to confirm the existence of cointegration. The null hypothesis of the no long run is $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$, against the alternative hypothesis: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$. The obtained f-statistics were compared with the lower- and upper-bound values given by Narayan (2005) to assess the existence of long-term relationship, because the given critical values are for the short-term data. A similar procedure was repeated for Eqs. (2.1), (3.1), and (4.1) to confirm the long-term cointegration relationship among variables.

The next step would be to calculate the error correction model and estimate the coefficients of the variables. The general form of Models 1.1, 2.1, 3.1, and 4.1 are, respectively as follows:

$$\begin{aligned}\Delta TR_t = {} & \delta_0 + \sum_{i=1}^{\kappa 1}\delta_{1i}\Delta TR_{t-i} + \sum_{i=0}^{\kappa 2}\delta_{2i}\Delta PD_{t-i} + \sum_{i=0}^{\kappa 3}\delta_{3i}\Delta GDP_{t-i} \\ & + \sum_{i=0}^{\kappa 4}\delta_{4i}\Delta FDI_{t-i} + \sum_{i=0}^{\kappa 5}\delta_{5i}\Delta K_{t-i} + \sum_{i=0}^{\kappa 6}\delta_{6i}\Delta URB_{t-i} \\ & + \eta_1 ECT_{t-1} + \varepsilon_{1t}\end{aligned} \tag{1.2}$$

$$\begin{aligned}\Delta ANS_t = {} & \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta ANS_{t-i} + \sum_{i=0}^{n2}\beta_{2i}\Delta PD_{t-i} + \sum_{i=0}^{n3}\beta_{3i}\Delta TR_{t-i} \\ & + \sum_{i=0}^{n4}\beta_{4i}\Delta FDI_{t-i} + \sum_{i=0}^{n5}\beta_{5i}\Delta E_{t-i} + \sum_{i=0}^{n6}\beta_{6i}\Delta URB_{t-i} \\ & + \eta_2 ECT_{t-1} + \varepsilon_{2t}\end{aligned} \tag{2.2}$$

$$\begin{aligned}\Delta ANS_t = {} & \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta ANS_{t-i} + \sum_{i=0}^{n2}\beta_{2i}\Delta TR_{t-i} \\ & + \sum_{i=0}^{n3}\beta_{3i}\Delta TRPD_{t-i} + \sum_{i=0}^{n4}\beta_{4i}\Delta FDI_{t-i} + \sum_{i=0}^{n5}\beta_{5i}\Delta K_{t-i} \\ & + \sum_{i=0}^{n6}\beta_{6i}\Delta E_{t-i} + \sum_{i=0}^{n7}\beta_{7i}\Delta URB_{t-i} + \eta_3 ECT_{t-1} + \varepsilon_{3t}\end{aligned} \tag{3.2}$$

$$\begin{aligned}\Delta PD_t = {} & \beta_0 + \sum_{i=1}^{n1}\beta_{1i}\Delta PD_{t-i} + \sum_{i=0}^{n2}\beta_{2i}\Delta INOV_{t-i} + \sum_{i=0}^{n3}\beta_{3i}\Delta TR_{t-i} \\ & + \sum_{i=0}^{n4}\beta_{4i}\Delta HB_{t-i} + \sum_{i=0}^{n5}\beta_{5i}\Delta FDI_{t-i} + \sum_{i=0}^{n6}\beta_{6i}\Delta E_{t-i} \\ & + \sum_{i=0}^{n7}\beta_{7i}\Delta URB_{t-i} + \eta_4 ECT_{t-1} + \varepsilon_{4t}\end{aligned} \tag{4.2}$$

In Eqs. (1.2), (2.2), (3.2), and (4.2), each ECT is the error correction term that shows the convergence path to long-term equilibrium in case of disturbance in the corresponding equation. η is the coefficient of error correction term (ECT) to show the time span that the system would take to reach the long-term equilibrium path.

Results and discussion

Unit root tests

The ARDL method is quite flexible, and it can be used for any order of integration if none of the variables is the second difference stationary. To make sure that none of the variables is second difference stationary, we considered three-unit root tests, namely, augmented Dicky–Fuller (ADF) (Dickey & Fuller, 1979), Kwiatkowski (KPSS; Kwiatkowski et al., 1992), and Phillips–Perron (PP) (Phillips & Perron,

Table 2
Unit root test results.

Variable	Level Stationary			First difference Stationary		
	ADF	PP	KPSS	ADF	PP	KPSS
ANS	−1.047(0.719)	−1.129(0.690)	0.580**	−4.228***(0.003)	−4.397***(0.002)	0.108
PD	−1.674(0.431)	−115.796***(0.000)	0.341***	−3.530***(0.001)	−3.437***(0.002)	0.305
GDP	−2.377(0.158)	−2.317(0.175)	0.694**	−3.467**(0.019)	−3.088**(0.042)	0.334
E	0.122(0.960)	−0.450(0.885)	0.602**	−2.616**(0.012)	−6.559***(0.000)	0.178
K	−3.433**(0.020)	−3.187(0.110)	0.145**	−5.264***(0.000)	−10.099***(0.000)	0.500
FDI	−2.077(0.255)	−2.438(0.142)	0.272**	−4.045***(0.005)	−5.340***(0.001)	0.070
URB	−1.867 (0.060)	0.443(1.000)	0.724**	1.297***(0.000)	−4.713***(0.005)	0.359
TR	−2.245(0.197)	−2.245(0.197)	0.719**	−4.230***(0.003)	−4.300***(0.003)	0.155
HB	−2.943*(0.056)	−4.713***(0.001)	0.715**	−4.037**(0.023)	−2.791*(0.075)	0.672**
INOV	−1.683(0.427)	−1.670(0.426)	0.356**	−3.347**(0.024)	−3.346**(0.001)	0.500**

***, ** and * represents 1%, 5% and 10% level of significance, respectively. P-value in Parentheses (). KPSS test judgment has been made based on asymptotic critical values by Kwiatkowski-Phillips-Schmidt-Shin (1992)).

Table 3
Bound tests result for the confirmation of cointegration.

Dep. Var.	F-Statistics	Decision
F_{TR}(TR/PD,GDP,FDI,K, URB)	5.25***	Cointegration
F_{ANS}(ANS/TR,PD,FDI,E, URB)	2.39	Inconclusive
F_{ANS}(ANS/TR,TRPD,FDI,K,E,URB)	4.10**	Cointegration
F_{PD}(PD/INOV,TR, HB, FDI,E, URB)	4.60***	Cointegration
Critical values for f-statistics	I0 Bound	I1 Bound
1%	{3.41},(3.15)	{4.68}, (4.43)
5%	{2.62},(2.45)	{3.79},(3.61)
10%	{2.26}, (2.12)	{3.35}, (3.23)

***, ** and * indicate 1%, 5% and 10% level of significance, respectively. Critical values are in {} are for the first two equations and () are for the last two equations. Akaike's information criteria have been taken under consideration for optimal lags. Source: Eviews 9.0 output.

1988) tests. The ADF and PP null hypothesis is the unit root against the alternative of stationary, whereas the KPSS null hypothesis is stationary against the alternative of a unit root. Table 2 confirms that all variables are either stationary at level or at the first difference, and none of the variables reaches the second difference.

Cointegration relation

In the second step, we estimated each equation with the OLS method to extract the coefficient estimates. Later, we imposed restrictions on the long-term coefficients to calculate the f-statistics. The f-statistics is highly sensitive to appropriate lags, and for this, we utilized Akaike's information criteria, which is suitable for a small sample to determine the optimal lag length (Ahmad & Du, 2017; Lutkepohl, 2006). Table 3 shows that the f-statistics for Eq. (1) is 5.25, which is higher than the upper-bound values at a 1% level of significance, confirming a strong long-term cointegration relation for the variables. For Eq. (2), we found the inconclusive results at a 10% level of significance as the calculated f-statistic falls between the value of the upper and lower bounds. In this situation, we utilized the negative and significant ECT as an alternative measure to confirm the cointegration association. For Eq. (3), the f-statistics of 4.10 is statistically significant at a 5% level. Eq. (4), which measures the influence of innovation on the pandemic, shows a strong cointegration relationship among variables, as the calculated f-statistics is 4.60, which is higher than the upper-bound values at a 1% level of significance.

Table 4
Pandemic impact on tourism arrivals.

	Short run	Long run
Variables	Coefficient	Coefficient
PD	0.004(0.003)	−0.009**(0.004)
GDP	1.864**(0.880)	0.297(0.389)
FDI	0.010(0.009)	0.015(0.014)
K	−0.003(0.003)	0.001(0.005)
URB	0.752***(0.240)	1.112**(0.408)
ECT		−0.676***(0.147)

***, ** and * indicate level of significance at 1%, 5% and 10%, respectively.
Standard error in parentheses ().

Findings and discussion

In our next step, we extracted the coefficients of the variables for each equation to interpret in elasticities. Table 4 presents the results when tourism arrivals is the dependent variable and the pandemic discussion is the main independent variable, along with economic growth, foreign and domestic investments, and urban population. We split our results into immediate (short-run) and long-run impacts. We found that the immediate impact of pandemic discussion on tourism arrivals is insignificant, whereas in the long run, pandemic discussion has a significantly negative impact on tourist arrivals of France. It means a rise in pandemic discussion inversely affects the tourism arrivals. The coefficient value also turns out to be doubling, compared with the immediate impact, revealing that pandemic discussion takes time to spread around and people stop tourism and travel within the time horizon. In other words, tourists are sensitive to pandemic information, and they make their travel plans based on information about the pandemic.

The results reveal that the real GDP per capita coefficient is statistically significant and positive in the short run, indicating that an increase in domestic income helps in international tourists' attraction. However, in the long run, perhaps, people become accustomed to the higher income. Thus, further economic expansion raises tourism arrivals but at a slow rate, because the coefficient remains positive but becomes insignificant. Urban population coefficients reveal that adding urban population increases the tourism in France, which indicates that urbanization can attract tourists. Moreover, urban population should involve sustainable tourism to generate employment opportunities and help in environmental correction plans. Domestic and foreign capitals have positive but insignificant effects on tourism, revealing a slow positive contribution to tourism development and appealing for more investment in sustainable tourism. The ECT has a coefficient of 0.68, and it is statistically highly significant, revealing that the system will converge to a long-run equilibrium path, with a 68% speed of adjustment annually or the system will take less than two years to reach its equilibrium path in case of disturbance in the system.

Table 5 shows that tourism development leads to sustainable development in France. Its unitary and highly significant coefficient stresses that the tourism industry has a key role in the sustainable development of France. Indeed, this industry is an important source

Table 5
Tourism arrivals and pandemic impact on sustainable development.

	Short run	Long run
Variables	Coefficient	Coefficient
PD	0.018(0.008)	0.020**(0.009)
TR	1.031*(0.590)	1.130**(0.560)
FDI	0.089***(0.029)	0.098***(0.030)
E	−0.740(0.475)	−0.811(0.571)
URB	−4.037***(1.047)	−4.425***(0.750)
ECT		−0.921***(0.189)

***, ** and * indicate level of significance at 1%, 5% and 10%, respectively.
Standard error in parentheses ().

Table 6
Tourism arrivals*pandemic impact on sustainable development.

	Short run	Long run
Variables	Coefficient	Coefficient
TR	0.092(0.064)	0.137(0.093)
TR*PD	0.017**(0.007)	0.026***(0.010)
FDI	0.052**(0.024)	0.078**(0.030)
K	0.016***(0.003)	0.023***(0.006)
E	−0.584(0.335)	−0.869(0.500)
URB	−2.106***(0.447)	−3.131***(0.479)
ECT		−0.673***(0.110)

***, ** and * indicate level of significance at 1%, 5% and 10%, respectively.
Standard error in parentheses ().

of revenue and generates employment opportunities for local people. Overall, the tourism market is highly competitive and quite global, and this industry is rapidly growing, with the potential to play an important role in the growth and development. The results show that the pandemic discussions have a significantly positive influence on the sustainable development of France. A 1% increase in the pandemic raises sustainable development by 0.020% in the long run. Thus, more pandemic discussion can lead to less involvement in business activities, and less energy consumption leads to more sustainability. Similarly, international travel bans and travel restrictions with limited flights and fewer public buses help to improve the environment.

Foreign investment positively contributes to the sustainable development of France, revealing that foreign investors are respecting France's efforts for sustainability by following the country's environmental policies for their projects. We found that the urban population coefficient was negative, revealing that the urbanization process is not helpful for sustainable development. The reason might be that the urbanization process leads to heavy energy consumption and thus more pollution emissions that hinder sustainability. The energy consumption coefficient has a negative and insignificant impact on the sustainable development of France. Thus, more energy consumption will not encourage sustainable development; rather, it will add to emissions problems that further hinder the sustainable path. It appeals to more renewable energy projects. The ECT was negative and highly significant at the 1% level of significance. The ECT value of 0.92 reveals that the system will take around a year to return to its equilibrium path in case of any disturbance.

Furthermore, we introduced the interaction between tourism arrivals and pandemic discussion (TR * PD). The interaction results in Table 6 show that a 1% increase in tourists who are aware of the pandemic contributes to the sustainable development by 0.017% in the short run, whereas a similar rise in the long run improves sustainability by 0.026%. This result confirms the positive and significant impact of interaction (TR * PD) on the sustainability of France. We found the significantly positive effects of foreign and domestic investments on

Table 7
Innovations' impact on the pandemic.

	Short run	Long run
Variables	Coefficient	Coefficient
INOV	−25.677**(10.180)	−58.225(34.811)
TR	−2.427(1.843)	−5.504(4.285)
FDI	−1.400**(0.399)	−3.173*(1.615)
HB	48.144**(20.039)	109.17**(48.693)
E	27.579***(8.363)	62.538**(28.353)
URB	130.689***(41.988)	296.345**(114.086)
ECT		−0.441**(0.156)

***, ** and * indicate level of significance at 1%, 5% and 10%, respectively.
Standard error in parentheses ().

the sustainable development of France irrespective of the short and long runs, revealing those investors care about the environment. The energy consumption coefficient is negative in the short and long runs, appealing to the introduction of renewable energy to fill the need for energy. The urban population coefficient is negative and statistically significant, revealing that a 1% increase in urban pollution reduces sustainability by 2.11% and 3.13% in the short and long runs, respectively. The ECT shows that the system will converge to its equilibrium path, with the speed of adjustment at 0.67% annually in case of disturbance in the system. In other words, it will take less than two years to reach its equilibrium if a disturbance occurs in the equilibrium.

Table 7 shows that a rise in innovation help to reduce the pandemic uncertainty in the short and long runs, with its negative coefficients. However, the short-term effect is more prominent compared with that of the long run, where the long-run coefficient is statistically insignificant. it's the reasons might be due to the fact that the pandemic is a short-term phenomenon, and in the long run, pharmaceutical and non-pharmaceutical measures are more active to counter the pandemic, where innovations play a focal role in controlling it. The results further show that a rise in foreign investment can help to reduce pandemic risk in the short and long runs; where a 1% rise in foreign investment reduces pandemic uncertainty by 1.4% in the short run, whereas a 1% rise in foreign investment reduces pandemic by 3.2% in the long run, revealing the foreign investment's positive contribution to health. Energy consumption adds to the pandemic discussion irrespective of the short and long runs, revealing that more energy consumption will attract media news and channels' discussion on the pandemic. We found that the addition of hospital beds augments to the pandemic discussion in the short and long runs, revealing that if there will be more patients during the pandemic, then they will discuss more on the pandemic. In this situation, positive news and media coverage can help to divert their attention to entrainment programs. The rise in urban population adds to the pandemic discussion in the short and in long runs, revealing that the urban population is active and attentive to the related news about the pandemic. An ECT of 0.44 has a negative and statistically significant coefficient, revealing that the system will converge to its equilibrium path with the speed of adjustment at 44% annually in case of disturbance in the system.

In sum up, the immediate influence of pandemic discussion on tourism arrivals is insignificant. However, in the long run, it turns out to be significant and negative, revealing that a rise in pandemic discussion reduces tourism arrivals. Conversely, we found that tourism arrivals and pandemic discussions have significant effects on the sustainable development of France. The interaction of tourism arrivals and pandemic discussion results reveals that tourists aware of the pandemic are helpful in the improvement of sustainability of France. While estimating the impacts of innovations on the pandemic, we found that innovations help reduce the pandemic uncertainty

Table 8
Diagnostic tests for the model performance.

Diagnostic tests	Null Hypothesis	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)
Breusch Godfrey serial Correlation LM test	H_0: No serial correlation	2.14(0.10)	1.36(0.29)	2.68(0.11)	1.29(0.31)
Heteroskedasticity Test: Breusch-Pagan-Godfrey	H_0: Homoskedasticity	2.14(0.98)	2.91(0.04)	0.76(0.63)	0.96(0.49)
ARCH test	H_0: Homoskedasticity	1.17(0.29)	0.03(0.86)	0.67(0.42)	0.08(0.78)
Normality	H_0: Residuals are normally distributed	0.60(0.74)	1.11(0.58)	1.39(0.499)	1.59(0.45)
Ramsey Reset test	H_0: model is correctly specified	0.30(0.59)	0.02(0.88)	6.017(0.03)	0.05(0.82)

Note: P-values in parentheses. Source: Authors' estimations using Eviews 9.0.

irrespective to the short and long runs. It appeals to focus on the innovative solutions that help counter the pandemic. Economic expansion was helpful in tourism development, which reveals that the economic development should be focused on to help tourism development and sustainability. Overall, we found that foreign and domestic investments positively contribute to the sustainable development of France, and foreign investment is also helpful in tourism development and reducing the risk of pandemic uncertainty. Energy consumption is not helpful in the sustainable development of France, revealing that focus should be made on renewable energy sources.

The results also reveal that it costs time to control travel and tourism during the pandemic. For example, when initial COVID-19 cases were discovered in January 2020, most of the countries have travel restrictions in March 2020 despite travelers' being inclined initially to travel even after March 2020, perhaps not knowing the sensitivity of the COVID-19 pandemic. However, more pandemic information and discussion make them sensitive to deciding about tourist places and travel plans. That is, tourists' future decisions depend on whether the country is free from pandemic with lower or zero cases and most of the people are fully vaccinated, which will give tourists confidence to make travel plans. The pandemic has a long history to adversely affect the tourism industry, which always have a key role in growth and development. Moreover, tourism and travel restrictions, quarantine policies, and scenic spot restrictions can limit energy consumption; thus, pandemic discussion helps toward sustainability. It is common to invest less and save more if there is more uncertain news about a pandemic, such as the second, third, or even fourth wave. If people have limited news about the pandemic that reflects the limited new cases, then people will be encouraged to the normality and can take risky decisions about the business and investment. Tourism-dependent economies are expecting to feel higher shocks of a pandemic than non-tourism-based economies. On this basis, we need to have the necessary protocol to boost travelers' confidence, such as travel vaccination passports. The tourism sector helps in sustainable growth by providing means of earning for local people. Encouragement of domestic tourists for economic recovery can be a choice.

Thus, the rise in pandemic discussion reduces tourism arrivals in the long run (RQ1), whereas tourism arrivals and pandemic discussion rise can significantly add to the sustainable development of France (RQ2), revealing that tourism recovery is important for the sustainable development of the country. Tourism and travel have been limited in France to overcome the pandemic, which also limits energy consumption during the phenomenon. Travel restrictions impositions on all tourist spots, hotels, motels, and restaurants until further notice help to improve environmental quality. The New York Times (2020) reported that cycling is becoming more common in Paris to avoid the risk of COVID-19. Overall, all these measures help to improve the environment. Higher economic growth and urbanization processes can play an important role in tourism development. Furthermore, the introduction of renewable energy can be a solution to not hurt growth and development, and it will not cause environmental pollution problem. It is the reason that France has always given priority to adjusting energy consumption by introducing renewable energy sources, including solar power plants and wind energy. In a Paris agreement, France has an important role to encourage 196 countries to jointly focus on the emissions problem where the introduction of renewable energy can play a key role.

We also found significant evidence that innovations have the opposite effects on the pandemic, revealing that a rise in innovations helps to reduce the pandemic (RQ3). Thus, relying on innovation, especially innovations related to countering the pandemic, will help to reduce pandemic risks. Such innovations include but are not limited to vaccines, masks, sanitizers, and all the digital solutions that help to prevent the risk of a pandemic. For example, the Chinese app Alipay helps to detect the travel history of people in the past 14 days and determine the color of code (i.e., green if no travel to risky areas, yellow if movement is in risky areas; and red reveals that the candidate has been in risky areas and must be quarantined, and health situation needs to be monitored). Similarly, installing digital check-in systems in airports and train stations can reduce the risk of the pandemic that stresses focusing on digital solutions by relying on innovations. More healthcare innovations will be a blessing to build confidence and reduce the risk of the pandemic. Furthermore, online shopping becomes more common during the pandemic and now it is a trend. Even when the pandemic is over, online shopping will be with us. Robot deliveries are on the rise, which helps avoid the pandemic by having less interaction among people. Thus, innovative digital solutions in e-commerce will be helpful to boost the consumption pattern of societies. All these measures urge us to think of better innovative solutions that are possible with international collaboration for the betterment of humanity and future generations.

Diagnostic tests

We used various diagnostic tests to confirm the reliability and performance of estimated models. Table 8 reports the results for all models (1, 2, 3, and 4), which show that models are free from serial correlation problems. Ramsey reset results show that the estimated models are correctly specified (Ahmad & Du, 2017). Heteroskedasticity tests show that there is no heteroskedasticity at a 1% level of significance. The ARCH tests confirm that the estimated models are free from ARCH effects. The Jarque–Bera's (JB) test confirms that the residuals follow a normal distribution in all models. The CUSM and CUSMSQ are often used to verify the stability of variables over the period (Brown et al., 1975). The CUSUM (Fig. 1) and CUSMSQ (Fig. 2)

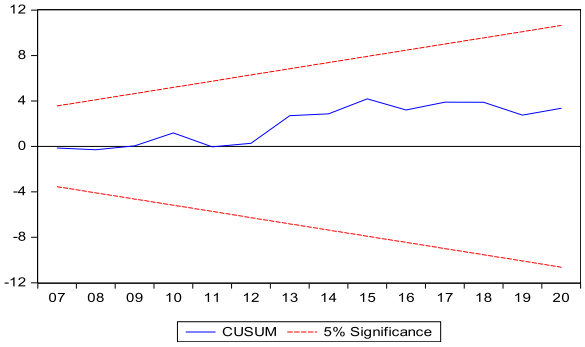

Fig. 1. CUSUM test for stability.

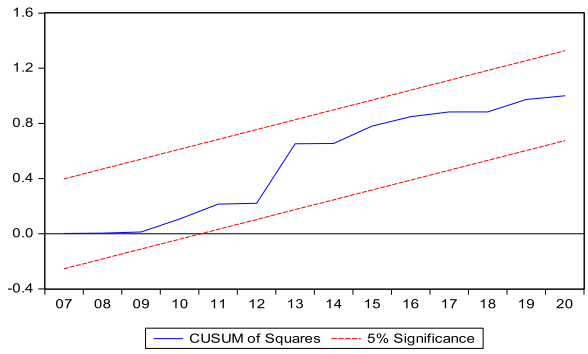

Fig. 2. CUSUM SQUARE test to show stability.

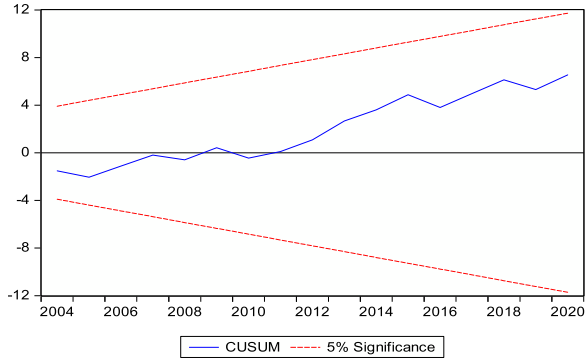

Fig. 3. CUSUM test for stability.

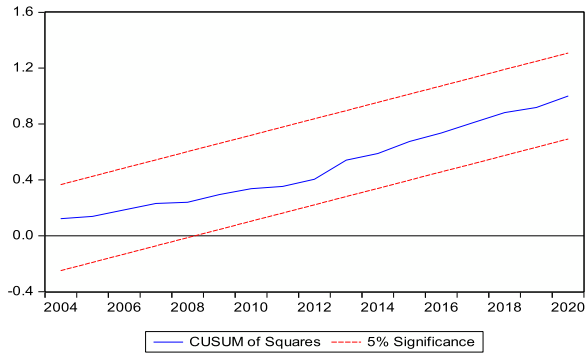

Fig. 4. CUSUM SQUARE test to show stability.

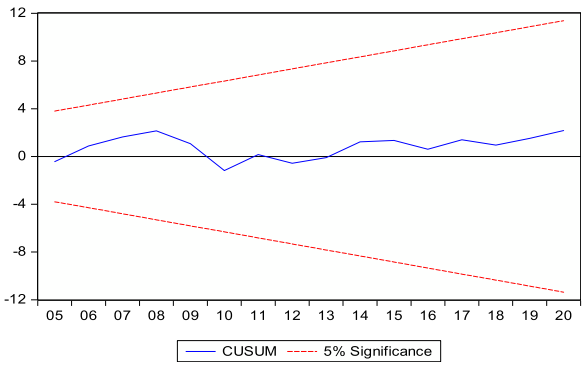

Fig. 5. CUSUM test for stability.

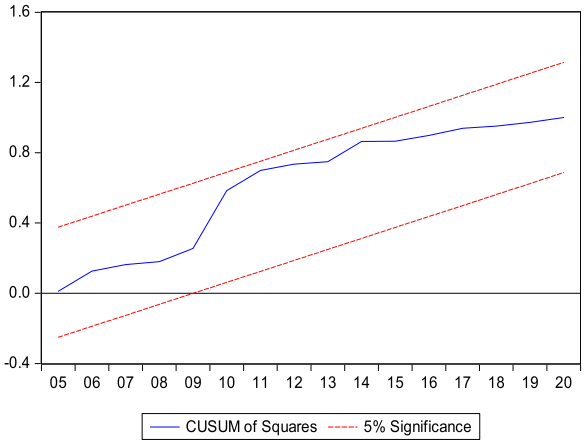

Fig. 6. CUSUM SQUARE test to show stability.

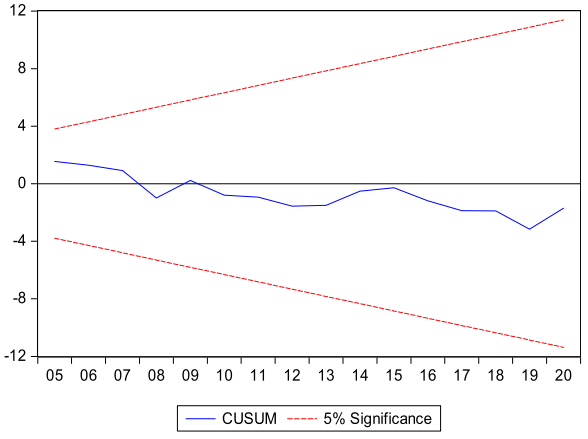

Fig. 7. CUSUM test for stability.

show that the estimated coefficients are stable over the period as critical values remain within the bounds for Model 1. The coefficients of Model 2, CUSUM (Fig. 3) and CUSMSQ (Fig. 4), and Model 3, CUSUM (Fig. 5) and CUSMSQ (Fig. 6), are stable over time. Similarly, Model 4 CUSUM (Fig. 7) and CUSMSQ (Fig. 8) show that the estimated coefficients are stable.

Robustness check: FMOLS and DOLS estimators

We adopted a FMOLS method to verify the robustness of ARDL estimates. FMOLS estimators outperform in small sample sizes and overcome endogeneity and serial correlation issues (Phillips & Hansen, 1990; Stock & Watson, 1993). FMOLS results in Table 9 show that a 1% increase in pandemic discussion decreases tourism arrivals by 0.006% in the long run, while a 1% increase in tourism arrivals adds to sustainable development by 1.085% in long run. Furthermore, the interaction term of tourism arrivals and pandemic discussion reveals that it has a positive significant long-run impact on the sustainable development of France. Overall, the results reveal that pandemic-related discussion leads to a decline in tourism arrivals while tourism arrivals have a positive significant impact on the sustainable development of France. Indeed, we find the pandemic discussion, as well as the tourist's awareness of the pandemic (TR * PD), add to sustainable development which is consistent with the above findings. Our long-run results show that innovations help to reduce pandemic uncertainty which is also consistent with our ARDL findings.

In addition to the above main results, our other results are also consistent with the ARDL outcome. For example, the results show that a 1% increase in foreign direct investment raises sustainable development by 0.10% in the long run, while a 1% increase in energy consumption leads to the reduction of sustainable development by

Table 9
FMOLS for robustness check.

Variables	Model 1	Model 2	Model 3	Model 4
PD	−0.006**(0.003)	0.024***(0.006)	–	–
TR	–	1.085**(0.387)	0.1399***(0.046)	−2.797(2.364)
TRPD	–	–	0.028***(0.005)	–
FDI	−0.013(0.011)	0.100***(0.022)	0.096***(0.015)	−0.694(0.503)
K	0.003**(0.002)	–	0.014***(0.002)	–
E	–	−0.700*(0.363)	−0.818***(0.245)	30.086***(10.885)
URB	0.367(0.315)	−4.280***(0.527)	−3.129***(0.236)	174.786(51.207)
GDP	0.925***(0.298)	–	–	–
INOV	–	–	–	−15.818(12.788)
HB	–	–	–	65.843**(24.584)
Adj.R^2	0.88	0.90	0.93	0.546

***, ** and * indicate level of significance at 1%, 5% and 10%, respectively.
Standard error in parentheses ().

Table 10
DOLS for robustness check.

Variables	Model 1	Model 2	Model 3	Model 4
PD	−0.061***(0.020)	0.032***(0.007)	–	–
TR	–	0.215***(0.076)	0.144**(0.065)	−0.774(2.797)
TRPD	–	–	0.026***(0.007)	–
FDI	−0.084(0.083)	0.145***(0.019)	0.093***(0.021)	
K	0.001(0.011)	–	0.014***(0.003)	–
E	–	−1.190***(0.363)	−0.662*(0.348)	27.379**(12.825)
URB	−1.270(2.178)	−3.356***(0.346)	−2.913***(0.327)	150.478**(56.278)
GDP	2.136(1.933)	–	–	–
INOV	–	–	–	−13.896(15.073)
HB	–	–	–	55.500*(26.765)
Adj.R^2	0.27	0.88	0.93	0.518

***, ** and * indicate level of significance at 1%, 5% and 10%, respectively.
Standard error in parentheses ().

0.70% in long run. Similarly, urbanization was having a negative impact on the sustainable development of France. The results further show that a 1% increase in real GDP per capita raises tourism arrivals by 0.925% revealing economic expansion will encourage tourism development as prosperity among the people mean that they will be willing to spend on tourism and travel activities. FDI was statistically insignificant while domestic capital remains positive and turned significant revealing appreciation in domestic capital encourages development in long run. We have also considered DOLS methods for robustness as FMOLS and DOLS yield identical results. The results in Table 10 reveal identical responses. For example, the DOLS results show that a 1% rise in pandemic discussion reduces tourism arrivals by 0.061% in the long run, while tourism arrivals have a positive significant impact on the sustainable development of France. Similarly, we found the pandemic discussion positive and significant impact on the sustainable development of France. While the interaction between tourism arrivals and the pandemic discussion was having a positive significant impact on sustainability. In addition to this, we find that innovations are helpful in reducing the pandemic uncertainty. Thus, overall, we found the robustness of ARDL findings with FMOLS and DOLS estimators that is important for policy purposes.

Table 11
Granger causality test.

Null Hypothesis:	F-Stat.	Prob.
INOV does not Granger Cause ANS	7.867	0.011
ANS does not Granger Cause INOV	0.071	0.793
TR does not Granger Cause ANS	5.597	0.028
ANS does not Granger Cause TR	0.440	0.514
PD does not Granger Cause ANS	0.522	0.478
ANS does not Granger Cause PD	0.604	0.445
URB does not Granger Cause ANS	4.152	0.054
ANS does not Granger Cause URB	0.730	0.402
FDI does not Granger Cause ANS	1.977	0.174
ANS does not Granger Cause FDI	5.904	0.024
TR does not Granger Cause INOV	4.795	0.040
INOV does not Granger Cause TR	3.099	0.092
URB does not Granger Cause INOV	1.872	0.185
INOV does not Granger Cause URB	15.999	0.000
PI does not Granger Cause TR	0.321	0.577
TR does not Granger Cause PD	2.948	0.101

Granger causality test

The Granger causality test was used to detect the direction of causal relationships among variables. Causality is a relationship between variables where it helps to explain one-way causal relation X is causing Y or Y is causing X- or two-way causal relation i.e. X is causing Y, and Y is causing X. There is also the possibility that X is not causing Y and Y is not causing X that means there is no causal relationship among two variables. Indeed, the Granger causality is a system hypothesis to detect if one series can be used to predict another (Wei, 2016). The results of the Granger causality test are reported in Table 11. The results validate the existence of one-way causal relation running from innovations to sustainability while sustainability does not Granger causes innovations. Results show that tourism arrivals Granger causes sustainable development while sustainable development does not Granger cause tourism arrivals. We find two ways causal relations between innovations and tourism arrivals where tourism arrivals Granger cause innovations and innovations Granger cause tourism arrivals. We find urban population was a Granger causing sustainability whereas sustainable development was not a Granger causing urbanization. However, sustainability was a Granger causing foreign investment. There was an absence of causal relation between pandemic and sustainability revealing that a pandemic does

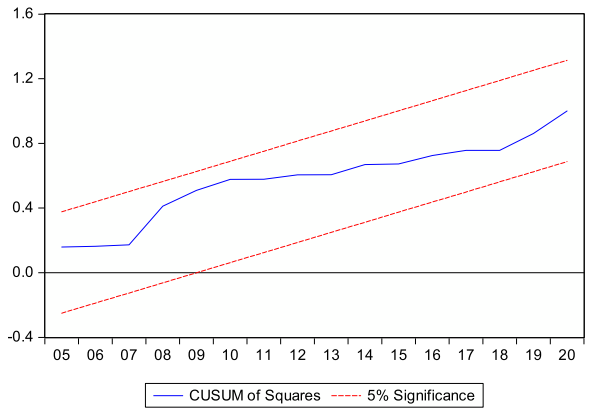

Fig. 8. CUSUM SQUARE test to show stability.

not Granger cause sustainability and vice versa. The results reveal that any policy related to innovation, sustainability, and tourism needs to be carefully considered based on the variables' causal relation and their influence on each other.

Impulse response function (IRF)

We attempted to measure out-of-sample causal relations by utilizing the authentic Cholesky IRF. Eangle and Granger (1987) have reported that IRF shows better performance under a VAR environment. So, we have utilized VAR prior to the IRF. IRF is a general response of one variable to another variable in the change of standard deviation of another variable (Ahmad & Du, 2017). We have introduced 5 years of shock by putting 5 periods in the shock block considering our modest sample. The results in Fig. 9 show that tourism arrivals' response to the pandemic discussion is negative and with the time horizon, it remains negative and even gets a bit steeper. It shows that if the news and information about the pandemic are on the rise, it will affect tourism arrivals. Furthermore, we find that pandemic information responses to sustainable development is positive which means that pandemic discussion and cases will put travel restrictions that will further improve sustainability. It also means that after the recovery from a pandemic, we need to care more about environmental policies to raise sustainable development. Interestingly, we observed that economic expansion has a positive response to sustainable development, and an increase in real GDP per capita is helping to raise the sustainable development of France. It means country is on track to meet the targets of the Paris agreement to significantly reduce its emissions per capita. We have also noted that a rise in sustainable development will bring more economic prosperity. Thus, overall, IRF responses are consistent with ARDL and FMOLS.

Conclusion and policy implications

The COVID-19 pandemic is a serious threat to the global village, and the travel and tourism industry is sensitive to the pandemic. This study provides a unique investigation and interlinkages among pandemic, tourism development, innovations, and sustainable development with the aim of sustainable recovery by relying on innovations and tourism development. The study answers the following research questions: How does pandemic impact the tourism development and sustainability in France? What is tourism's role in the sustainable development of France? What is the role of innovations in pandemic control? These are important questions as the answers will determine future works and how innovations and digitization solutions can help in a sustainable recovery. To answer these questions, we utilized data sets from the period of 1996–2020 for the pandemic discussion, tourism arrivals, innovations measured in the number of patents application by the residents of the country, sustainable

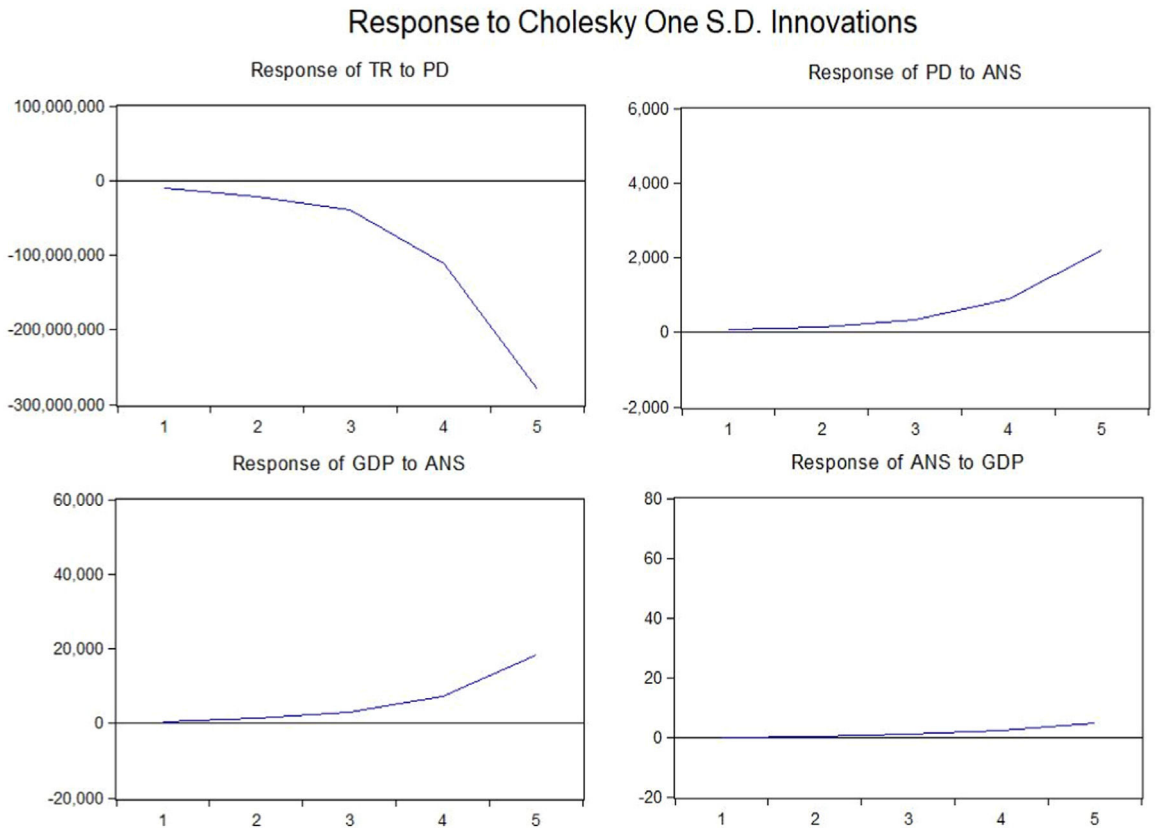

Fig. 9. Impulse response function.

development, real GDP, foreign direct investment, gross fixed capital formation, energy consumption, and hospital beds. The ARDL to cointegration method has been used to extract facts while robustness has been done via FMOLS and DOLS that all outperform in small sample size and make the model dynamic to further overcome the endogeneity issue.

Our empirical findings illustrate several important findings. First, we find that the pandemic discussion downturns tourism arrivals while tourism was having a key role in the sustainable development of France. The reduction in tourism arrivals means lower growth and development as the empirical evidence also confirm that tourism arrivals have a strong positive association with the sustainable development of France. We find the pandemic discussion positive impact on sustainable development while innovations' helpful role in pandemic control. It highlights a twofold response. That is, sustainability has been improved during the pandemic as people fear and governmental pandemic control policies were supportive to have fewer industrial and travel activities, as a result, it brings improvement in environment. However, since a pandemic cannot be a desirable strategy for sustainability and it has already cost heavy economic and life losses, so one need to rely on innovative solutions for recovery. In this regard, our results further point out that innovations are helpful to control the pandemic and a rise in innovation reduces the risk of a pandemic. To sum up, we find that tourism is important for sustainable development in France, and the pandemic has a negative impact on it. The tourism arrivals and pandemic interaction was having helpful role in the sustainability of France. We also identify that innovations have a helpful contribution to pandemic control revealing the fact that future works should be based on more innovative solutions to help in pandemic control and sustainable recovery.

We find some other important policy results. For example, the urban population was having a positive significant impact on tourism arrivals that further adds to the sustainable development of France. On the other hand, urbanization was having an inverse impact on the sustainable development of France revealing to focus on environment friendly projects for urbanization. Thus, we need to encourage the urban population to environment-friendly industries and projects so that they can significantly contribute to the sustainable development of France. Similarly, foreign investment role was positive and significant in the sustainability, while energy consumption was having a negative impact on the sustainable development that encourage in the introduction of renewable energy and foreign investment to renewable energy-related projects. Overall, results are important for the post-pandemic sustainable recovery that appeal to rely on future innovations and innovative solutions to counter pandemic and help in tourism development.

Policy implications

Considering that the current study explores the relationship among pandemics, innovations, sustainable development, and tourism, it presents better expectations for policy perspectives of future sustainable works for France.

To summarize, we have extracted important policy points:

(1) We find the pandemic's negative influence on tourism arrivals where significant tourism declines have been observed with the rise in news and information about the pandemic.
(2) Tourism arrivals was having a significant positive association with the sustainable development revealing the importance of tourism industry.
(3) Pandemic discussion was having a positive significant impact on the sustainable development of France.
(4) The rise in innovations was having a helping role in pandemic control that appeal to focus on innovations that will further raise growth and development as well as help in overcoming the pandemic.

From the above results and considering the pandemic's devasting impact, it is important to adopt a strategy to relieve public fear and gives confidence on tourism and travel. More innovations in healthcare are important to reduce the pandemic's risk and to boost the confidence for future works that is necessary for sustainable recovery. Protective measures such as mask usage are always important while outside as we are aware that vaccines are not the silver bullets to counter the disease. News and media can play important role in tourism recovery where tourism was important for the sustainability of France. Government and travel agencies can help to offer tours and travel packages, coupons, and discounts on transport and planes. Similarly, tourist operators may offer discounts such as a night's free stay. It is fact that the pandemic has helped in environmental correction as most of the economic activities requiring heavy energy absorption were closed or slowed down, however, the pandemic is not an environmental solution. Rather, we should not forget the long-run impacts once travels will be resumed, industries and factories will re-start the work. Thus, it is important to change energy consumption patterns to renewable energy injecting no emissions and fulfill our needs without compromising the need of future generations.

A future extension can be to add more relevant variables, such as political risk, inflation, exchange rate, infrastructure, and many more macroeconomic factors that can potentially help to further understand the pandemic, innovation, tourism, and sustainable development associations for France and for other economies. Our analysis was conducted within relatively short data considering pandemic data constraints. Thus, future research can have more observations and more variables to investigate pandemic's impact on various sectors of the economy at aggregate and/or firm levels. Furthermore, we use secondary data to investigate the pandemic's impact on tourism arrivals, innovations, and sustainable development as well as tourism impacts on the sustainable development of France. Future works can utilize primary data based on the questionnaire methods. It is hoped that this research will stimulate future research.

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