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## Measuring the persistence degree of shocks to the US tourism markets: new evidence for COVID-19 pandemic period

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### ABSTRACT

Regarding the huge negative effects of the COVID-19 pandemic on the tourism market of the US, we investigate the persistent degree of the shocks to three markets: overseas, Canada, and Mexico. To measure persistence degree and its dynamics, we apply the Fourier quantile unit root test and rolling-window indirect inference estimators. Overall results indicate (i) negative shocks to the US' tourist markets have more long-lasting effects than positive ones, (ii) degree of persistence of all three markets increased due to the COVID-19 pandemic, and (iii) Canada tourist market displays more persistence behaviour than the other two markets.

### KEYWORDS

Tourism market; persistence; Fourier quantile unit root; indirect inference estimator; rolling window

### JEL CLASSIFICATION

C22; O51; Z32

## 1. Introduction

The tourism industry stimulates the economic growth of the host country by increasing the foreign revenues, investment in infrastructure, financing the import of capital goods, the transmission of accelerating effects to other industries via backward linkages, and economies of scale (Balaguer and Cantavella-Jorda 2002). However, the performances of the industry are affected by political/geopolitical risks and instabilities, financial/economic crises, and pandemics (Antonakakis, Dragouni, and Filis 2015). The recent huge downturn of the tourism industry has occurred due to the COVID-19 pandemic. The virus was first identified in China, in December 2019, and then it spread around the world rapidly, which has affected 221 countries and territories up to October 2021. Due to human-to-human transmission property of the disease and negative effects of the pandemic on the health of people, governments of most countries had to impose some restricted laws, e.g. social distancing laws. Also, most countries had to impose restrictions on international mobility to stop the spread of the disease across countries. These strict restrictions have resulted in a huge recession in the tourism sector from the year 2020. According to World Travel and Tourism Council (2021), due to

this pandemic and ongoing restrictions to international mobility, (i) the spending of domestic and international visitors reduced by 45% and 69% in the year 2020 than the previous year, respectively, (ii) the share of global GDP of the travel and tourism sector reduced from 10.4% in 2019 to 5.5% in 2020, and (iii) recession of the sector caused 62 million job losses in the year 2020. Also, empirical studies found that the COVID-19 pandemic affected the tourism industry in several directions. For example, Ren et al. (2022) found that it has persistence negative effects on travel behaviour in Korea. Deb and Nafi (2020) found that the disease reduced the number of flights and booking and employment in the tourism sector in Bangladesh. Fu and Pulido-Fernández (2020) found that the COVID-19 pandemic seriously decreased the rooms occupied, occupancy rate, total operating revenue, and the number of employees in Taiwan. In another study, Cheng and Kao (2022) found that it negatively affects the job satisfaction in the hotel industry of Taiwan. Mandel and Veetil (2020) found China and world lockdown, which are due to COVID-19 pandemic, reduced the world production by 7% and 23%, respectively.

According to the World Travel and Tourism Council report (2021), the US was the top country

across the world in terms of travel and tourism contribution to GDP in 2019. Overall, 8.6% of the total GDP of the US was related to the travel and tourism industry in 2019, which reduced to 5.5% in 2020. In addition, 16.6 million jobs were created by the travel and tourism industry in the US in 2019, which reduced to 11.1 million jobs in 2020. The total spending of international visitors from the US was \$181.2 billion in 2019, which reduced to \$42.2 billion in 2020. Thus, due to the COVID-19 pandemic, the total contribution of travel and tourism industry to GDP and employment of the US reduced about 41% and 33%, respectively, and the international visitors' spending reduced by 76.7% in the year 2020 than 2019, which mainly are due to strictly imposed restrictions on international and domestic mobility.

Regarding (i) the important role of the travel and tourism industry in the US economy (as were discussed above), (ii) the long-run effects of the industry on the US economic growth (see for example Sharif, Saha, and Loganathan 2017; Hatemi-J et al. 2014), and (iii) considerable negative effects of the COVID-19 pandemic on the US tourism industry (as reported by the World Travel and Tourism Council), analysing the persistence degree of negative shocks to tourism industry, which occurred due to the outbreak of COVID-19, is an important subject and has considerable policy implications. According to neoclassical growth theory, shock on growth fundamentals (of a country or a sector, e.g. tourism industry) has transitory effects on economic growth rates of countries over the transition period and will disappear in the long-run. In contrast, the endogenous growth theories, e.g. Romer (1986), predict that the shocks may have long-lasting effects on economic growth (Ranjbar et al. 2015). If the COVID-related negative shocks exhibit persistent behaviour, the recession of the tourism industry will likely continue and affect the economy via two channels that include (i) reducing revenue of economic agents, which exist in the tourism industry, investment on tourism-related infrastructures, and employment of the industry and (ii) transmission of negative shocks to other industries via forward and backward linkages of the industry.

It is the most common way in the applied economic literature and tourism literature (e.g. Gil-

Alana and Payne 2022; Payne et al. 2021; Tang and Wong 2009) that researchers apply unit root/stationary tests to measure degree of persistence of time series variables. If a time series variable, e.g. foreign tourist arrivals in our cases, exhibits a stationary process, it means shocks to the series have transitory effects and will disappear in the short-run. In contrast, if a series behaves as a unit root process, then shocks to series will have long-lasting effects. Accordingly, testing existence of a unit root in the data-generating process of time series of number of foreign tourist arrivals to a destination has important policy implications for policy-makers and messages for empirical modelling of tourist demand. If time series of number of foreign tourist arrivals exhibits a unit root process, it means government policies towards the industry's development or to mitigate the negative effects of exogenous shocks, e.g. COVID-19 pandemic, will likely have permanent effects and will disappear only in the long-run. In contrast, if the series behaves as a stationary process, the short-run policy interventions will likely be unable to push the industry. From the empirical modelling side, if a time series of number of foreign tourist arrivals exhibits a unit root process, researchers likely have to include the past values of the variable in the empirical models to control for its short-run dynamics.

As noted by Andrzej and Rodrigues (2010), there are some possibilities that the persistence degree (or stochastic behaviour) of a time series variables will change over a time period; therefore, its order of integration alters from  $I(1)$  (or unit root process) to  $I(0)$  (stationary process) and vice versa. Analysing the persistence change of time series of tourist arrivals over a time period allows us to investigate the effects of various exogenous or endogenous shocks to tourism industry. If due to a specific shock, e.g. the COVID-19 pandemic, the stochastic properties of tourist arrivals alter from  $I(0)$  to  $I(1)$ , then it means the shock will have long-lasting effect on the industry. In contrast, if the order of integration of time series variable alters from  $I(1)$  to  $I(0)$ , it means the series behaves as a stationary process and the shock will disappear in the short-run. There remains another possibility that the series will behave as a stationary process before and after the shock but the degree of

persistence increases after the shock. In the case, the shock will disappear but over the longer period than before the shock occurred.

Regarding considerable effects of the COVID-19 pandemic on tourism industry, the main objective of this article is to investigate changing the persistence degree of time series of foreign tourist arrivals from Canada and Mexico as two main source countries of foreign visitors of the US and overseas (which includes all other source countries). Accordingly, in this article, we try to test the following hypotheses:

*The degree of persistence of time series of tourist arrivals from Canada, Mexico, and overseas (which includes all other source countries) to the US increased due to the COVID-19 pandemic.*

To the best of our knowledge, this is the first study which analyses changing persistence degree of shocks to the tourism industry of the US over the outbreak of COVID-19.<sup>1</sup> To this end, we apply two approaches: the Fourier quantile unit root test (FQURT, hereafter and which was developed by Bahmani-Oskooee et al. 2018) and the rolling window indirect inference estimator (IIE, hereafter and which was developed by Phillips, Wu, and Yu 2011). The former measures the quantile-varying persistence degree of the time series variable and the latter measures the time-varying persistence

degree of the time series variable. FQURT has three important properties: (i) good performance in the presence of non-normal distribution, (ii) controlling for unknown form, number, and dates of smooth breaks in the deterministic terms (intercept/trend), and (iii) allowing for the quantile-varying autoregressive term, which measures persistence degree within each quantile of time series variable. Using the rolling window IIE, (i) we were able to correct the downward bias of OLS-estimated autoregressive term, and (ii) we were able to analyse changing persistence degree of the time-series variable over time. Other parts of this article are designed as follows: the data and methodology are described in Sections II and III, respectively. The empirical results are presented in Section IV, and the conclusion is discussed in Section V.

## II. Data description

Based on a report of the National Travel and Tourism Office of the US, we divided international visitors of the US into three markets: Canada, Mexico, and overseas (which includes other source countries). We collected monthly data of three mentioned tourism markets over the period 1999M1 to 2021M7.

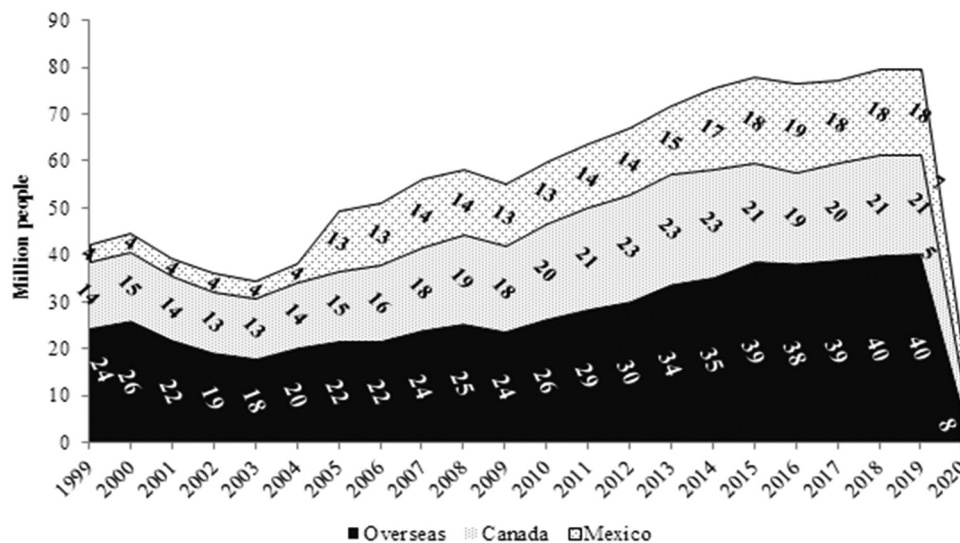


Figure 1. Dynamics of overseas, Canada, and Mexico tourist arrivals to the US.

<sup>1</sup>Recently, Payne et al. (2021) analysed the changing persistence degree of Croatian tourism market using fractional integration model.

In Figure 1, we display the yearly dynamics of tourist arrivals (in million people) from overseas, Canada, and Mexico to the US over the period 1999–2020. On average, about 49%, 31%, and 20% of total foreign visitors of the US are related to overseas, Canada, and Mexico, respectively, over the period. Accordingly, we select Canada and Mexico as main sources of foreign tourists to the US and analyse the stochastic behaviours of three time series variables.<sup>2</sup>

As seen, the number of foreign visitors from three markets to the US increased over the period 1999–2019. But due to the COVID-19 pandemic, the US' foreign visitors reduced from 79.4 million people to 19.4 million people. Our findings indicate that the number of overseas, Canada, and Mexico visitor arrivals to the US reduced 81%, 77%, and 62%, respectively, in the year 2020 than 2019.

### III. Methodology

In this section, we describe the FQURT and IIE, which are applied to measure the changes of persistence degree of tourist arrivals.

#### Fourier quantile unit root test

The FQURT is conducted in a two-step procedure. Firstly, the time series variable  $TOR_t$  is de-meaned using the following Fourier expansion:

$$TOR_t = \theta_1 + \theta_2 \sin\left(\frac{2\pi kt}{N}\right) + \theta_3 \cos\left(\frac{2\pi kt}{N}\right) + \varepsilon_t \quad (1)$$

$N$ ,  $t$ ,  $k$ , and  $\pi$  are sample size, linear trend, frequency, and 3.13, respectively. The OLS estimator is applied to estimate the regression model (1) using the optimal value of  $k$ . In the second step, the OLS residuals of Equation 1 are used as dependent variables in the following ADF regression model and the quantiles regression is applied to the estimation of the model:

$$Q_{\varepsilon_t}(\tau) = \alpha_0(\tau) + \alpha_1(\tau)\hat{v}_{t-1} + \sum_{l=1}^{l=h} \alpha_{1+l}(\tau)\Delta\hat{v}_{t-l} + \varepsilon_t \quad (2)$$

The coefficient  $\alpha_1(\tau)$  measures the persistence degree of time-series variable  $TOR_t$  within quantile  $\tau$ . The  $\alpha_0(\tau)$  measures the magnitude of shocks to  $\tau$  quantile of  $TOR_t$ . We use the AIC criteria to choose the optimal number of lag(s) to omit the serial autocorrelation of error term  $\varepsilon_t$ .

To test the null hypothesis of unit root within the quantile  $\tau$ , the following  $t_n(\tau_i)$  is computed:

$$t_n(\tau_i) = \frac{f(F^{-1}(\tau_i))}{\sqrt{\tau_i - \tau_i^2}} (\Pi'_{-1} \Gamma_s \Pi_{-1})^{1/2} (\hat{\alpha}_1(\tau_i) - 1) \quad (3)$$

where  $G$  is an estimator of  $f(F^{-1}(\tau_i))$ .  $\Pi_{-1}$  and  $\Gamma_x$  are the first lag of  $\hat{t}$  and projection matrix onto  $S = (1, \hat{t}_{-1}, \dots, \hat{t}_{-h})$ . Bahmani-Oskooee et al. (2018) recommend using the following Kolmogorov–Smirnov statistics ( $QKS_{LFS}$ ) to test the null hypothesis of unit root over  $\tau_i \in [0.1, 0.9]$ :

$$QKS_{LFS} = \sup |t_n(\tau_i)| \quad (4)$$

We use the bootstrap procedure of Bahmani-Oskooee et al. (2018) to compute the critical values of  $t_n(\tau_i)$  and  $QKS_{FS}$  statistics.

#### Indirect inference estimator

Suppose the data-generating process of the stochastic variables  $TOR_t$  is as follows:

$$TOR_t = \pi + \mu TOR_{t-1} + \sum_{k=1}^q \theta_k \Delta TOR_{t-k} + \varepsilon_t \quad (5)$$

where  $\pi$  is the intercept of the model and  $\mu$  (sum of AR coefficients) measures half-life or persistence degree of shocks to time series variable  $TOR_t$ . The terms  $\sum_{k=1}^q \theta_k \Delta TOR_{t-k}$  are included in the regression model to control for serial correlation in the residuals ( $\varepsilon_t$ ) and the optimal numbers of lags (say  $q^*$ ) are selected using AIC information criteria.

<sup>2</sup>The stochastic behaviours of other source countries of foreign visitors of the US may be analysed in the future works. But to save the space, we do not analyse the data-generating process of these time series variables.

Most of the empirical studies applied the OLS to estimate the coefficient  $\mu$  (say  $\hat{\mu}_{ols}$ ). However, the  $\hat{\mu}_{ols}$  is downward-biased in the small samples and near unit root processes. To crop the bias of  $\hat{\mu}_{ols}$ , Phillips, Wu, and Yu (2011) developed the following IIE of  $\mu$  (say  $\hat{\mu}_{IIE}$ ):

$$\hat{\mu}_{IIE} = \underset{\mu_h \in \Omega}{\operatorname{argmin}} \left\| \hat{\mu}_{ols} - \frac{1}{W} \sum_{n=1}^W \widehat{\mu}_{h,n}(\mu_h) \right\| \quad (6)$$

We set  $\Omega$  as a compact interval  $[0, \dots, 1.5]$ .  $\mu_h \in \Omega$  and using OLS-estimated coefficients of  $\theta_l$ , we generate  $W$  (number of replications) pseudo-series of  $TOR_t$  (say  $\widetilde{TOR}_t$ ), re-estimate the regression model (5) by each  $\widetilde{TOR}_t$  series, save the estimated  $\widehat{\mu}_{h,n}(\mu_h)$ , and finally compute average  $\widehat{\mu}_h(\mu_h)$  ( $\frac{1}{W} \sum_{n=1}^W \widehat{\mu}_{h,n}(\mu_h)$ ).

The  $\hat{\mu}_{IIE}$  is selected where distance between  $\hat{\mu}_{ols}$  and average  $\widehat{\mu}_h(\mu_h)$  is minimized. Phillips, Wu, and Yu (2011) demonstrated theoretically that if  $W \rightarrow \infty$ , then  $\hat{\mu}_{IIE} = \operatorname{argmin} \left\| \hat{\mu}_{ols} - E\left(\widehat{\mu}_{h,n}(\mu_h)\right) \right\|$ . Whereas the  $\hat{\mu}_{IIE}$  considerably crops the bias of  $\hat{\mu}_{ols}$ , it is applied to measure the persistence degree of time series variable  $TOR_t$ . To measure dynamics (changes) of persistence degree of time series variable, we apply the Kruse and Wegener (2020) approach, which recommended using the IIE to estimate the rolling window of AR model (5) with  $m$  observations (window size).

#### IV. Empirical results

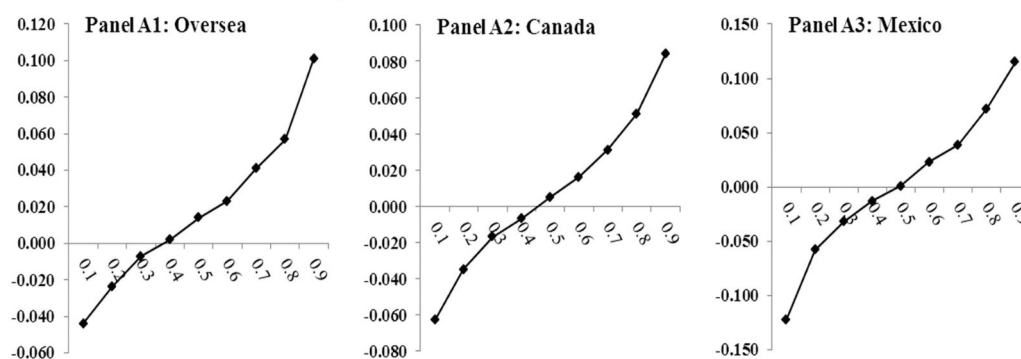
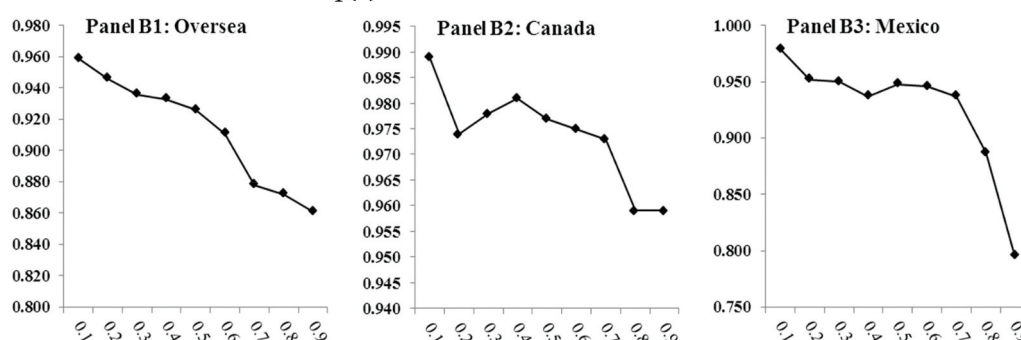
We prepare the results of the FQURT in Figure 2 for the time series of visitor arrivals (VA, hereafter) from Canada, Mexico, and other countries (overseas, hereafter) to the US. The estimated values of  $\alpha_0(\tau)$  in panel A of the figure indicate that low quantiles, i.e.  $\tau \in [0.1, \dots, 0.4]$  (high quantiles, i.e.  $\tau \in [0.6, \dots, 0.9]$ ), of three VA time series indicate negative (positive) shocks to the series. The estimated values of  $\alpha_1(\tau)$  in panel B indicate a downward slope over quantiles  $\tau \in [0.1, \dots, 0.9]$ , which indicates that the negative shocks to VA time series have more long-lasting effects than positive ones. The half-life of shocks (which is computed as  $\frac{\ln(\alpha_1(\tau))}{\ln(0.5)}$ ) to quantiles  $\tau \in [0.1, \dots, 0.9]$  of three VA time series in panel C indicates (i) the Canada series displays more

persistence behaviour than other two series, (ii) the largest negative shocks to three time series (i.e. quantile 0.1) have highest half-life and equal 16, 63, and 33 months for VA time series from overseas, Canada, and Mexico, and (iii) the average half-lives of positive (negative) shocks to VA from Canada, Mexico, and overseas are 23, 9, and 6 (39, 18, and 12) years, respectively.

The statistics of  $t_n(t_i)$  test are prepared in panel D, and triangle, circle, filled square, and blank square-shaped markers in the figures indicate the statistics are statistically significant at 10%, 5%, 1%, and insignificant ones, respectively. According to the results, all quantiles overseas, quantiles greater than 0.1 for Canada, and quantiles greater than 0.3 for Mexico display stationary behaviour at least at a 10% significance level. The statistics of  $QKS_{LFS}$  test equal 15.368, 3.802, and 3.021 for overseas, Canada, and Mexico series, respectively, which are statistically significant at 5% level (their bootstrap critical values at 5% are 2.615, 2.626, and 3.004). Thus, according to the  $QKS_{LFS}$  test, the null hypothesis of unit root is rejected for three series, but time series of Canada and Mexico display heterogeneous persistence behaviour across quantiles.

To measure the dynamics of persistence degree of three VA time series, we estimated autoregressive coefficients  $\mu_{OLS}$  and  $\mu_{IIE}$  by rolling window scheme with 50 observations over the period and display the results in Figure 3 (for overseas (in panel A), Canada (in panel B), and Mexico (in panel C)). The solid black and dashed red lines in the figure are rolling  $\hat{\mu}_{IIE}$  and  $\hat{\mu}_{OLS}$ , respectively. Comparing the values of  $\hat{\mu}_{IIE}$  with  $\hat{\mu}_{OLS}$  for three VA time series indicates (i) difference between two estimators is not fixed over time, so, in some dates, two estimators are very close, and some other times, there are non-negligible differences between them and (ii) the persistence degree of three time-series variables changes considerably over time. So, over some sub-periods, they behave as stationary processes, and over some others, behave as explosive processes.

The results of rolling  $\hat{\mu}_{IIE}$  for VA from overseas indicate the time series exhibits persistence behaviour over the most months of the period. Over the period 2015–2019, the persistence degree of the

Panel a : Estimated values of  $\alpha_0(\tau)$ Panel b : Estimated values of  $\alpha_1(\tau)$ 

Panel c : Half-life

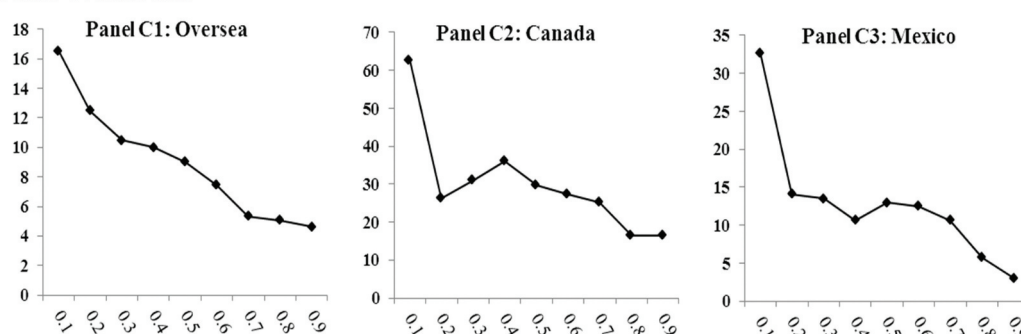
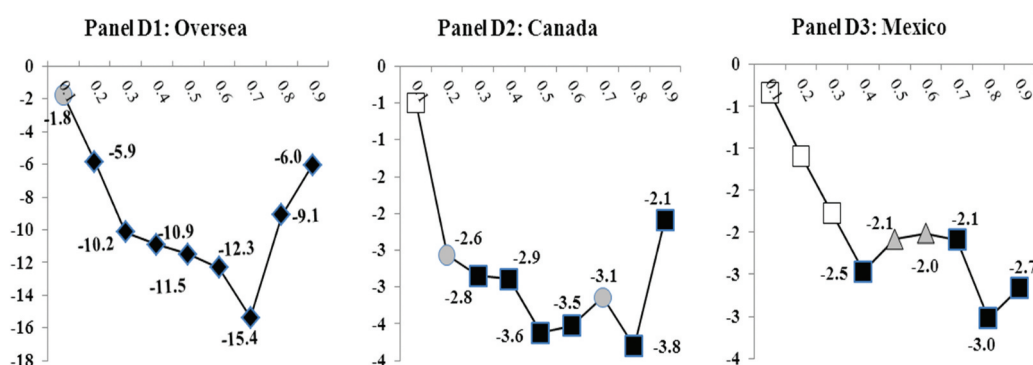
Panel d : the computed values of  $t_n(\tau_i)$ 

**Figure 2.** The results of FQURT. Note: Triangle, circle, square, and blank square-shaped markers indicate the estimated coefficients are statistically significant at 10%, 5%, 1%, and insignificant ones, respectively.

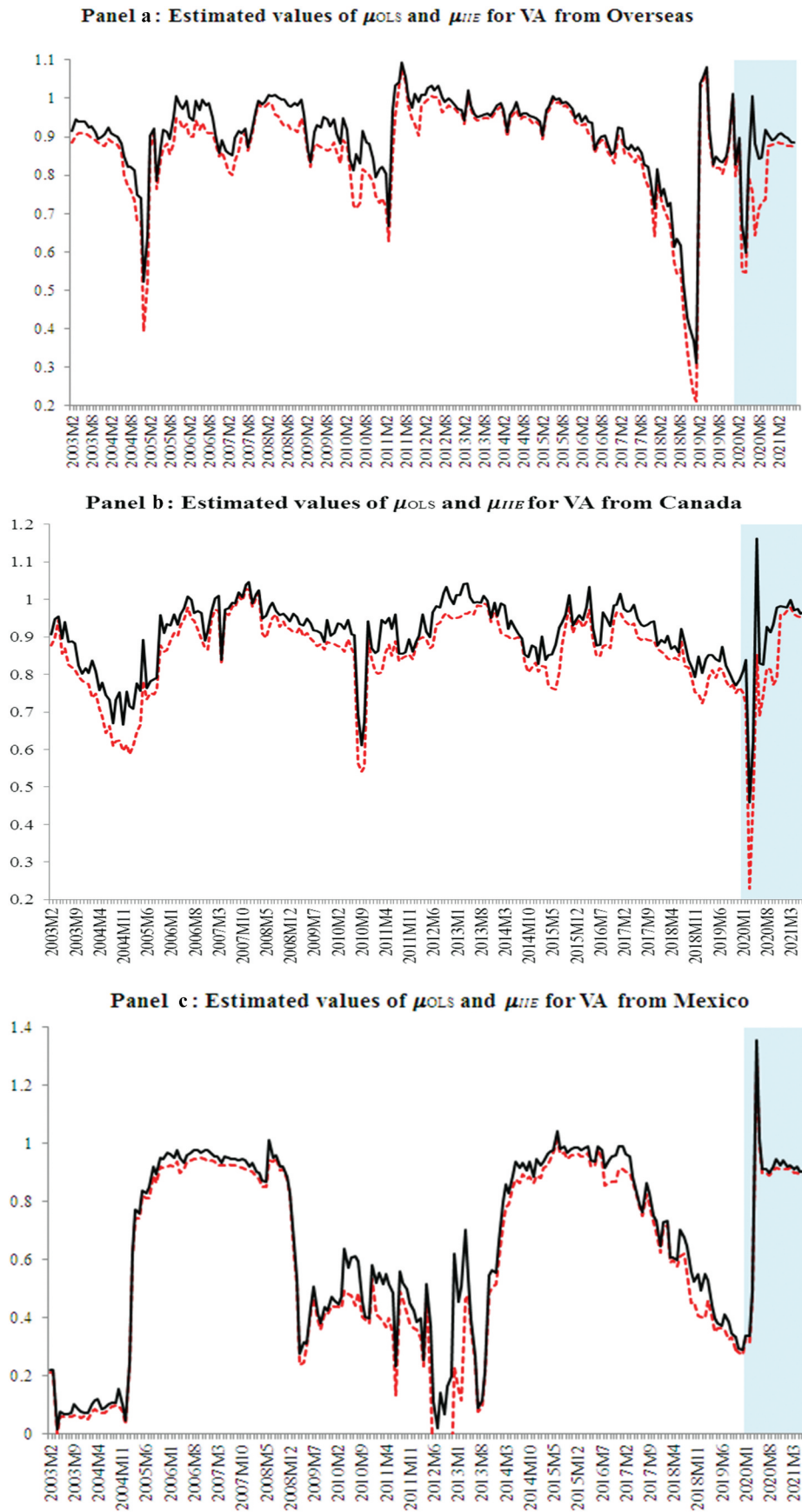


**Figure 3.** Time-varying  $\hat{\mu}_{OLS}$  and  $\hat{\mu}_{IE}$  over the period 2003M02 to 2021M0. Note: The solid black and dashed red lines in the figure are rolling  $\hat{\mu}_{IE}$  and  $\hat{\mu}_{OLS}$ , respectively.

overseas reduced considerably from 1.001 (month 2015M07) to 0.312 (month 2019M01) and then increased considerably. From the beginning of the COVID-19 pandemic up to now, the persistence degree of overseas displays some fluctuations, but over the period from 2020M07 to 2021M07, the average  $\hat{\mu}_{IIE}$  of the series was almost fixed and about 0.889. The results indicate the half-life of shocks to the overseas series is about 5.9 months.<sup>3</sup>

The results of rolling  $\hat{\mu}_{IIE}$  for the VA from Canada indicate the coefficient changes between 0.9 and 1 over most years of the period 2003–2017. But over the period 2017–2019, it reduces considerably from 1.014 to 0.786. But due to the COVID-19 pandemic, the  $\hat{\mu}_{IIE}$  increased from 0.786 in 2019M12 to 0.966 in 2021M07. According to the results, the half-life of shocks to the Canada series is about 20.3 months.

The results for VA from Mexico indicate the series behaves as high persistence or stationary process over the period 2003–2017. But over the period 2017–2019, the  $\hat{\mu}_{IIE}$  reduced from 0.990 (highly persistent process) to 0.293 (highly stationary process). From 2020, when the COVID-19 pandemic began, the degree of persistence increased and reached 0.903 in 2021M07, which indicates a half-life of about 6.8 months.

## V. Conclusion

Due to the COVID-19 pandemic, the tourism markets of the US (which is divided into Canada, Mexico, and overseas in this article) experienced a considerable downturn from the year 2020, which likely negatively affected the value added, investment, and employment of the industry and its downstream and upstream industries. Accordingly, analysing the persistence degree of COVID-19's negative shock to tourism markets of the US is very important. To this end, we applied FQRTs, which allow for quantile-varying persistence degree and rolling IIE, which allows for a time-varying degree of persistence. We found almost similar results using the two methods as follows: (i) negative shocks to tourism markets of the US are more persistent than positive ones.

According to our results, COVID-related negative shocks have more long-lasting effects on the Canadian tourism market than Mexico and overseas. (ii) Due to negative shocks of the COVID-19 pandemic, the persistence degree of all three tourism markets increased from 2020.

According to our results, disappearing the COVID-related shocks and bouncing back towards the previous steady-state level will occur over the long transition period. Also, regarding the short half-life of positive shocks, it is recommended that the federal and local governments of the US implement recovery packages, e.g. debt finance and tax-related interventions (a reduction in goods and services tax to make holidays cheaper), cash grants and subsidies, introducing more competitive hotel pricing and air ticket prices with long horizon to restore the tourism sector and its related industries including hospitality, food services, hotels, and transport to its pre-pandemic levels. However, there are some possibilities that the COVID-related negative shocks have reduced the equilibrium path of the foreign tourist arrivals, which needs the strong intervention of the US government.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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<sup>3</sup>By expanding the time period of our study up to 2022:05, we found that the number of foreign arrivals from overseas, Canada, and Mexico has bounced back but did not reach the number of foreign arrivals at the end of 2018. The figures are prepared upon request.

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## Appendices

### Appendix A: Data description

In Figure A1, we display the yearly dynamics of tourism arrivals (in million people) from overseas, Canada, and Mexico to the US over the period 1999–2020. On average, about 49%, 31%, and 20% of total foreign visitors of the US are related to overseas, Canada, and Mexico, respectively, over the period. As seen, number of foreign visitors from three markets to the US increased over the period 1999–2019. But due to the COVID-19 pandemic, the US' foreign visitors reduced from 79.4 million people to 19.4 million people. Our findings indicate that the number of overseas, Canada, and Mexico visitor arrivals to the US reduced 81%, 77%, and 62%, respectively, in year 2020 than 2019.

### Appendix B: Fourier-quantile unit root test

To test the null hypothesis of unit root within the quantile  $\tau$ , the following  $t_n(\tau_i)$  is computed:

$$t_n(\tau_i) = f(F^{-1}(\tau_i)) / \sqrt{\tau_i - \tau_i^2 (\Pi_{-1}' \Gamma_s \Pi_{-1})^{1/2} (\hat{\alpha}_1(\tau_i) - 1)} \quad (\text{B1})$$

where  $G$  is an estimator of  $f(F^{-1}(\tau_i))$ .  $\Pi_{-1}$  and  $\Gamma_x$  are the first lag of  $\hat{\tau}$  and projection matrix onto  $S = (1, \hat{\tau}_{-1}, \dots, \hat{\tau}_{-h})$ . Bahmani-Oskooee et al. (2018) recommend using the following Kolmogorov–Smirnov statistics ( $QKS_{LFS}$ ) to test the null hypothesis of unit root over  $\tau_i \in [0.1, \dots, 0.9]$ :

$$QKS_{LFS} = \sup |t_n(\tau_i)| \quad (\text{B2})$$

We use the bootstrap procedure of Bahmani-Oskooee et al. (2018) to compute the critical values of  $t_n(\tau_i)$  and  $QKS_{FS}$  statistics.

### Appendix C: Indirect Inference Estimator

Phillips (2012) developed the following indirect inference estimator (IIE, hereafter) of  $\mu$  (say  $\hat{\mu}_{IIE}$ ):

$$\hat{\mu}_{IIE} = \underset{\mu_h \in \Omega}{\operatorname{argmin}} \hat{\mu}_{ols} - \frac{1}{W} \sum_{n=1}^W \widehat{\mu}_{h,n}(\mu_h) \quad (\text{C1})$$

We set  $\Omega$  as a compact interval  $[0, \dots, 1.5]$ .  $\mu_h \in \Omega$  and using OLS-estimated coefficients of  $\theta_b$ , we generate  $W$  (number of replications) pseudo-series of  $TOR_t$  (say  $\widetilde{TOR}_t$ ), re-estimate the regression model (5) by each  $\widetilde{TOR}_t$  series, save the estimated  $\widehat{\mu}_{h,n}(\mu_h)$ , and finally compute average  $\widehat{\mu}_h(\mu_h)$

$(\frac{1}{W} \sum_{n=1}^W \widehat{\mu}_{h,n}(\mu_h))$ . The  $\hat{\mu}_{IIE}$  is selected where distance between  $\hat{\mu}_{ols}$  and average  $\widehat{\mu}_h(\mu_h)$  is minimized. Phillips (2012) demonstrated theoretically that if  $W \rightarrow \infty$ , then  $\hat{\mu}_{IIE} = \underset{\mu_h \in \Omega}{\operatorname{argmin}} \hat{\mu}_{ols} - E(\widehat{\mu}_{h,n}(\mu_h))$ .

Whereas the  $\hat{\mu}_{IIE}$  considerably crops the bias of  $\hat{\mu}_{ols}$ , it is applied to measure the persistence degree of time series variable  $TOR_t$ . To measure dynamics (changes) of persistence degree of time series variable, we apply the Kruse and Wegener (2020) approach, which recommended using the IIE to estimate the rolling window of AR model with  $m$  observations (window size).

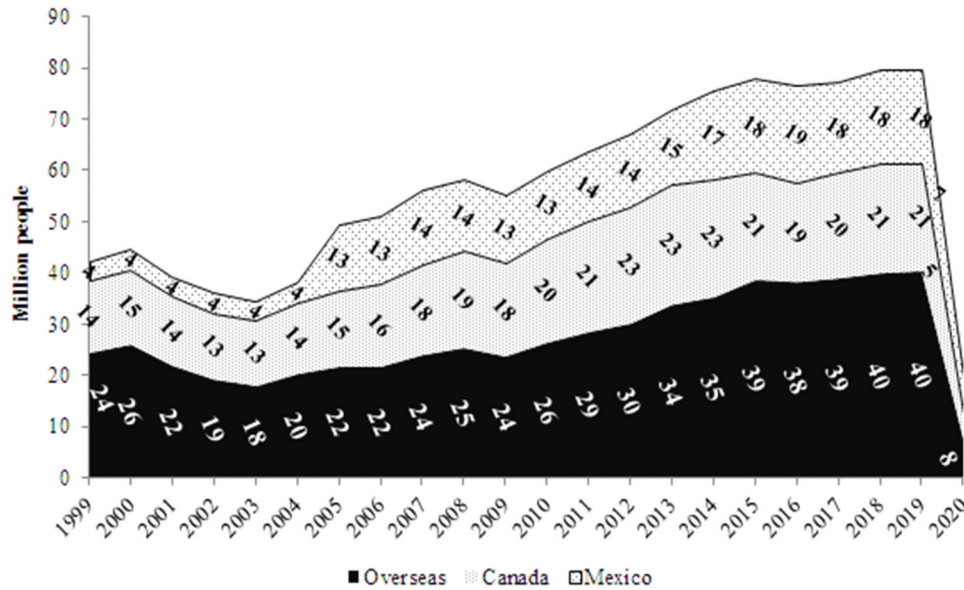


Figure A1. Dynamics of overseas, Canada, and Mexico tourists arrivals to the US.