Article

Nexus Between Travel & Leisure Stocks and Uncertainties: An Extreme Risk Spillover Analysis

American Business Review
May 2023, Vol.26(1) 245 - 268

ISSN: 2689-8810 (Online)
ISSN: 0743-2348 (Print)

Dilip Kumar[a]

https://doi.org/10.37625/abr.26.1.245-268

ABSTRACT

The paper examines the presence of risk spillover to the US travel & leisure industry from the extreme changes in the uncertainties. More specifically, using a time-varying copula based conditional Value-at-Risk (CoVaR) framework, we evaluate the dynamic impact of the uncertainties on the extreme risk of the US travel & leisure industry by taking into consideration the uncertainty in economic policy, equity market conditions, and crude oil prices. The findings indicate a significant dynamic inverse relationship between the returns of travel & leisure industry and changes in uncertainty variables. The results further indicate the stronger sensitivity of the travel & leisure industry toward the uncertainties in financial market and crude oil prices. We find significant evidence of extreme upside and downside risk spillover to the US travel & leisure industry from excessive downward and upward changes in uncertainties respectively. The findings also demonstrate the asymmetric effect of extreme movements in uncertainty factors on the tail risk of the US travel & leisure industry. The findings of the study have ramifications for risk managers, portfolio managers and investors.

KEYWORDS

Extreme Risk Spillover, Copula, Uncertainties, US Travel & Leisure Industry

INTRODUCTION

Travel & leisure industry is an essential part of the economy and has been recognized as a key driver for economic expansion (De La VIina et al., 1994). The travel & leisure industry contributed US$8.9 trillion to the world economy in 2019. The travel & leisure industry supported more than 300 million jobs and with capital expenditure of more than US$ 900 billion (WTTC, 2020). Over the last decade, the travel & leisure industry in the US has experienced tremendous volatility and price increase. The US travel & leisure stock indices recently had a sharp decline in value during the traumatic COVID-19 crisis in March 2020, however, following that, the indices recovered and began to trend higher through the end of December 2020. Due to the significant role of the travel & leisure industry in creating employment (Jaforullah, 2015), driving GDP growth rate (WTTC, 2020), and acting as an important means of economic recovery (WTTC, 2020), the travel & leisure sector is one of the important constituents of the funds managed by many portfolio managers.

Literature provides evidence that different sources of uncertainties including uncertainty related to economic policies, financial markets and energy prices can significantly impact the performance of travel & leisure industry firms in a market (Chen et al., 2012; Grechi et al., 2017; Kumar, 2023; Seraphin, 2017). Chen et al. (2012) highlight the major role of uncertainty in energy prices and uncertainty in various macroeconomic variables in impacting the performance of Japanese travel & leisure industry firms. Grechi et al. (2017) highlight that policy uncertainty has a significant impact on how well tourism

---

[a] Indian Institute of Management Kashipur, India

Corresponding Author:
Kumar (dilip.kumar@iimkashipur.ac.in)

businesses function. The effects of financial market turbulence, pandemics, and geopolitical crisis on tourism stocks are well examined by Seraphin (2017) and Kumar (2023). Such external sources of uncertainties significantly contribute to the systematic risk of the given firm's stock (Lintner, 1965). Such risk cannot be diversified away simply by making a portfolio and should be priced by a rational investor while making investment decisions (Drakos, 2004).

The uncertainties associated with the financial and commodity markets, as well as in economic policy may influence the valuation of the stock in a market (Chen et al., 2012). The market participants estimate the stock's fair value considering the discounted value of future cash flows which can be a dividend or free cash flow to equity discounted by the cost of equity under discounted cash flow approach (Ross et al., 2008). Higher values of uncertainty variables indicate the prevalence of fear and may trigger market decline and lead investors to postpone their investment decisions. Moreover, the increased economic uncertainty can lead to a decline in earnings and free cash flow to equity of the travel & leisure firms. This may be due to postponing the expenditure on non-essential services as the consumer may be hesitant to spend on vacation and leisure activities (Dragouni et al., 2016). Such postponement of expenditures by consumers can adversely impact the cash flows of travel & leisure firms. This causes a drop in the value of expected cash flows from equity, whether in the form of dividends or free cash flow to equity and thus a drop in stock prices in a market. Moreover, during periods of high uncertainty, the firm reduces the capital expenditure and investment and holds the major part of the current asset in the form of cash which increases the cost of capital associated with a firm (Ersan et al., 2019).

As highlighted by Barrero et al. (2017), uncertainties have both long- and short-term effects on different sectors in an economy and highlight that long-term investment decisions are particularly influenced by long-term uncertainty and are primarily characterized by economic policy uncertainty (EPU) and short-term uncertainty is mainly connected with uncertainties associated with equity and crude oil markets (Barrero et al., 2017). In this study, we explore the extreme risk spillover from both long- and short-term sources of uncertainties to the US travel & leisure industry indices. This will enhance the understanding of how the extreme risk of travel & leisure industry reacts to extreme changes in uncertainty associated with economic policy, equity market and crude oil market. We estimate the extreme risk of the US travel & leisure industry conditional on the extreme fluctuations in uncertainties using a time-varying ARMA-GJR-GARCH-copula-CoVaR approach. Then we investigate the presence of extreme upside and downside risk spillover from excessive upward and downward movements in uncertainties to the US travel & leisure stock indices using Kolmogorov-Smirnov (KS) test. We also investigate the possibility of asymmetric extreme risk spillover to the US travel & leisure industry from various uncertainty factors.

The contribution of the study is threefold. First, it is the first study to examine the time-varying linkages between the US travel & leisure industry's stock performance and uncertainties related to financial market, economic policy and crude oil prices throughout diverse market situations. Second, the study extends the literature related to risk contagion in tourism sector (Cepni et al., 2022; Kumar, 2023; Shahzad et al., 2022) by highlighting the role of uncertainty factors in increasing the extreme risk of US travel & leisure industry stocks. Third, it is the first study to show that the extreme variations in the uncertainty factors asymmetrically transmit the risk to the US travel & leisure industry stocks.

LITERATURE REVIEW

INFLUENCE OF ECONOMIC POLICY UNCERTAINTY (EPU)

To address both short-term and long-term issues related to economic uncertainty, Baker et al. (2016) proposed an estimate of economic policy uncertainty (EPU) considering media coverage of events

---

such as macroeconomic and political events, market recessions, financial market collapses, wars, etc. Following the development of EPU measure, the studies related to tourism literature started using EPU to analyze the impact of EPU: (1) on performance of tourism firms as increased EPU adversely influence the consumers' sentiment and desire to use tourism products and services as consumers are driven to delay or curtail their spending during such times in order to cope with the escalating uncertainty (Gozgor & Ongan, 2017; Grechi et al., 2017), (2) in lowering capital expenditures and investments in tourism firm as increased EPU may reflect a possibility of uncertain cash flows in future, which may cause a tourism firm to delay making capital expenditures and investments as a cautionary step (Cheng & Chiu, 2018), (3) in raising the cost of capital of the firm as increased EPU may increase the market risk (Cheng & Chiu, 2018), (4) in impacting the financial decisions of the tourism firms (Demir & Ersan, 2018), and (5) on tourism growth and revenue (Demir & Gözgör, 2018), and (6) on the risk of the tourism firms (Kumar, 2023). Before the year 2016, many studies considered periods of crises, economic stress, wars, and terrorist acts or EPU measure as suggested by Baker et al. (2016) in a working paper as a representation of periods of increased economic uncertainty and examined the impact of increased economic uncertainty on the profitability of tourism firms (Genc et al., 2006), stock returns of tourism firms (Chen et al., 2010), and stock volatility (Liu & Zhang, 2015). Most previous studies related to tourism literature have examined the average impact of EPU on different factors related to tourism industry firms. However, the extreme changes in EPU are highly relevant from the perspective of market practitioners and policymakers as they can adversely influence the stability of the market (Al-Thaqeb et al., 2022). In this study, we propose to examine the impact of extreme changes in the EPU measure on the extreme risk of the US travel & leisure industry.

INFLUENCE OF FINANCIAL MARKET UNCERTAINTY (VIX)

Literature suggests the use of market volatility index (VIX) as a proxy of market fear and financial market uncertainty (Akdağ et al., 2019; Whaley, 2000). It has been extensively researched in the literature on how VIX affects the economy and the financial market (Huang & Wang, 2017; Ozair, 2014). Literature also emphasizes how VIX affects tourism industry stock prices (Akdağ et al., 2019). Akdağ et al. (2019) investigate how VIX affected tourism industry stocks in 11 different nations. Using causality and co-integration analyses, Akdağ et al. (2019) discover that the rise in the VIX values has a considerable and adverse impact on the performance of the tourism stock indices. They discover a long-term link between the VIX and indices returns related to the tourism industry. Aharon (2020) also confirms the findings of Akdağ et al. (2019) by highlighting the relevance of volatility index (VIX) in influencing the performance of the US tourism sector stocks.

INFLUENCE OF UNCERTAINTY IN CRUDE OIL PRICES (CVIX)

Tourism sector is visibly reliant on crude oil because of its intrinsic transportation and leisure components and because of its influence on the supply and demand of tourism (Becken, 2008). Theoretically, rising oil costs can impact tourism activities through indirect and/or direct pathways. Higher oil costs would cause inflation, reducing travelers' wages and influencing their travel decisions, visiting places, and travel costs. Shock to energy prices may have an equivalent impact on the cost of service and production in numerous industries, including tourism industry. This can have a negative impact on the cost of tourism activities and thus influencing tourism industry in aggregate (Kisswani et al., 2020). Furthermore, there are a number of highly sensitive tourism activities, such as leisure activities that rely heavily on crude oil byproducts including airline travel, cruise travel, jet boating, etc. and shock to energy prices can negatively influence the performance of respective firms (Becken, 2011). Several studies have highlighted the adverse influence of increasing crude oil prices on the

---

performance of tourism industry (Becken, 2011; Becken & Lennox, 2012). They discover that crude oil price shocks not only adversely affect the tourism industry in terms of increased expenditures but also the income of potential travelers, who may opt to postpone their vacation plans if their income falls.

The previous literature highlights the significant role of various sources of uncertainties in influencing the travel & leisure industry firm's stock performance. However, the changes in values of uncertainty variables near the mean of the distribution may not be that relevant from the perspective of market practitioners having exposure to travel & leisure industry firms, instead, it will be more relevant, how extreme changes in uncertainty variables can influence the extreme risk associated with the travel & leisure industry stocks exposure (Kumar, 2023). Additionally, prior research has not explored the dynamic link between the US travel & leisure industry stocks' risks and uncertainties, which is vital to study the responsiveness of the risk of the US travel & leisure industry stocks to the tail risk associated with uncertainty factors. The current study investigates the extreme risk spillover to the US travel & leisure industry from uncertainty related to the equity market, crude oil prices and economic policy. This will enhance the understanding of how the travel & leisure stock indices react to extreme risks related to the given sources of uncertainties. The hypotheses to be tested are given at the end of the Methodology section.

METHODOLOGY

Extreme risk spillover analysis is significant from the viewpoint of risk management and can be analyzed based on different measures including CoVaR (Reboredo et al., 2016) and connectedness (Diebold & Yılmaz, 2014). We follow four steps approach. In the first step, we estimate the extreme risk of the series based on value-at-risk (VaR). Next, we calculate the joint density using the time-varying copula, which encapsulates the time-varying relationship. Then, conditional on extreme changes in uncertainties, we estimate the tail risk of the travel & leisure indices as CoVaR estimate. Finally, using Kolmogorov-Smirnov (KS) test, we test for the presence of risk spillover.

VaR ESTIMATION

First, we start with the estimation of VaR for the US travel & leisure indices and the various uncertainties based on univariate marginal modeling as follows. We first model the return series, $R_{i,t}$, considering appropriate order ARMA(p,q) model based on AIC (Akaike information criterion):

$$\begin{aligned} R_{i,t} &= \mu_{i,t} + \sum_{j=1}^{p} \theta_j R_{i,t-j} + \sum_{k=1}^{q} \delta_k \varepsilon_{i,t-k} + \varepsilon_{i,t} \\ \varepsilon_{i,t} &= z_{i,t}\sigma_{i,t} \end{aligned} \tag{1}$$

where $z_{i,t} \sim iid(0,1)$. We consider GJR-GARCH(1,1) model to estimate the series' conditional variance:

$$\sigma_{i,t}^2 = \omega + \alpha_1 \varepsilon_{i,t-1}^2 + \gamma_1 \varepsilon_{i,t-1}^2 I_{t-1}^- + \beta_1 \sigma_{i,t-1}^2 \tag{2}$$

where I_{t-1}^- is an indicator variable taking value one if $\varepsilon_{i,t-1} < 0$, else zero. The GJR-GARCH(1,1) captures the leverage effect (if $\gamma_1 > 0$) which is an important stylized fact while modeling marginal distribution of the series.

Next, we estimate the extreme risk, Value-at-Risk (VaR), of the series based on the mean ($\mu_{i,t+1}$) and volatility ($\sigma_{i,t+1}$) forecasts based on the marginal model:

$$VaR_{i,t+1,\alpha} = \mu_{i,t+1} + z_{i,\alpha}\sigma_{i,t+1} \tag{3}$$

---

where $z_{i,\alpha}$ is the α-quantile of iid (independently and identically distributed) series $z_{i,t}$.

MODELING JOINT DISTRIBUTION

The interaction between uncertainties and returns of travel & leisure industry stocks can possibly be non-linear and asymmetric. During times of severe market fluctuations or crises, this relationship may become more apparent. The Pearson correlation measure cannot capture asymmetry and non-linearity in a relationship. However, copula-based measures can very well capture asymmetry and non-linearity in a relationship (Patton, 2006) and are appropriate to be considered here.

Copula function is a multivariate distribution function with marginal to be uniform (0,1). We first take the given series ($R_t = (R_{1,t}, R_{2,t})$, residuals based on the marginal models), then we estimate empirical cumulative distribution function of the given series as uniformly distributed marginals. Using the uniformly distributed marginal of two series ($R_{1,t}$ and $R_{2,t}$, conditional on information set $\mathcal{F}_{t-1} = \sigma(R_{t-1}, R_{t-2}, \ldots, R_1)$ with $R_t = (R_{1,t}, R_{2,t})$), the conditional multivariate distribution function based on copula is given as:

$$F_t\langle \chi_1, \chi_2 | \mathcal{F}_{t-1}; \theta\rangle = C_t\big(F_{1,t}(\chi_1 | \mathcal{F}_{t-1}; \theta_1), \big(F_{2,t}(\chi_2 | \mathcal{F}_{t-1}; \theta_2)\big| \mathcal{F}_{t-1}; \theta_C\big) \quad (4)$$

where $\theta = (\theta_1', \theta_2', \theta_C')', C_t(.,.|\mathcal{F}_{t-1})$ is a conditional copula function and $F_{1,t}(.|\mathcal{F}_{t-1}), F_{2,t}(.|\mathcal{F}_{t-1})$ are $R_{1,t}$ and $R_{2,t}$'s conditional marginal distributions.

Using the dynamic copula-based equation (Patton, 2006) given below, we generate time-varying estimates of the dependence between the travel & leisure industry indices returns and uncertainty variables:

$$C_t(u_1, u_2 | \mathcal{F}_{t-1}; \theta_C) = C_t(u_1, u_2; \vartheta_t), u_i = \big(F_{i,t}(\chi_i | \mathcal{F}_{t-1}; \theta_i)\big), i = 1,2 \quad (5)$$

We consider Normal, t, Gumbel, SJC and Clayton time-varying copulas and consider the dependence parameter of best-fit copula to generate CoVaR estimates (Liu et al., 2017). These copula models are able to capture different tail dependence structures across different asset classes (Liu et al., 2017). We estimate the upper tail dependence, lower tail dependence, upper-lower tail dependence and lower-upper tail dependence parameters using the best-fit copula model.

CoVaR ESTIMATION

We estimate CoVaR of the US travel & leisure indices returns as the extreme risk (VaR) of the US travel & leisure indices returns conditional on the fact that the uncertainties have experienced extreme movement. The CoVaR helps us to estimate the extreme risk of the given series conditional on extreme movements in the other series. Suppose $R_{1,t}$ is the return of the travel & leisure stock index and $R_{2,t}$ represents changes in the values of a given uncertainty factor, then the upper tail dependence is estimated based on the upside CoVaR of the travel & leisure stock index given the upward extreme movements in the uncertainty factor ($CoVaR^{U,\alpha}_{(1|2U,t)}$) and is given as:

$$P\left(R_{1,t} \geq CoVaR^{U,\alpha}_{(1|2U,t)} \middle| R_{2,t} \geq VaR^{U,\beta}_{2,t}\right) = \alpha \quad (6)$$

Consequently, the lower tail dependence is estimated based on the downside CoVaR of the travel & leisure stock index given the downward extreme movements in uncertainty factor ($CoVaR^{D,\alpha}_{(1|2D,t)}$) and is given as:

$$P\left(R_{1,t} \leq CoVaR^{D,\alpha}_{(1|2D,t)} \middle| R_{2,t} \leq VaR^{D,\beta}_{2,t}\right) = \alpha \tag{7}$$

To capture lower-upper and upper-lower tail dependence, we estimate $CoVaR^{D,\alpha}_{1|2U,t}$ and $CoVaR^{U,\alpha}_{1|2D,t}$. We build these estimates based on Liu et al. (2017). The lower-upper tail dependence is estimated based on the downside CoVaR of the travel & leisure stock index given the upward extreme movements in uncertainty factor ($CoVaR^{D,\alpha}_{(1|2U,t)}$) and is given as:

$$P\left(R_{1,t} \leq CoVaR^{D,\alpha}_{(1|2U,t)} \middle| R_{2,t} \geq VaR^{U,\beta}_{2,t}\right) = \alpha \tag{8}$$

The upper-lower tail dependence is estimated based on the upside CoVaR of the travel & leisure stock index given the downward extreme movements in uncertainty factor ($CoVaR^{U,\alpha}_{(1|2D,t)}$) and is given as:

$$P\left(R_{1,t} \geq CoVaR^{U,\alpha}_{(1|2D,t)} \middle| R_{2,t} \leq VaR^{D,\beta}_{2,t}\right) = \alpha \tag{9}$$

For the given travel & leisure stock returns and uncertainty pair, $R_t = (R_{1,t}, R_{2,t})$, with copula-based dependence structure $C_t(u_1, u_2|\mathcal{F}_{t-1}; \theta_C)$ and marginal distributions $\left(F_{i,t}(\chi_i\middle|\mathcal{F}_{t-1}; \theta_i\right)$, the equations (6), (7), (8) and (9) are given as:

$$P\left(R_{1,t} \leq CoVaR^{D,\alpha}_{(1|2D,t)} \middle| R_{2,t} \leq VaR^{D,\beta}_{2,t}\right) = \frac{P\left(R_{1,t} \leq CoVaR^{D,\alpha}_{(1|2D,t)}, R_{2,t} \leq VaR^{D,\beta}_{2,t}\right)}{P(R_{2,t} \leq VaR^{D,\beta}_{2,t})} = \frac{C_t\left(F_{1,t}\left(CoVaR^{D,\alpha}_{(1|2D,t)}|\mathcal{F}_{t-1};\theta_1\right), \beta|\mathcal{F}_{t-1};\theta_c\right)}{\beta} \tag{10}$$

$$P\left(R_{1,t} \geq CoVaR^{U,\alpha}_{(1|2U,t)} \middle| R_{2,t} \geq VaR^{U,\beta}_{2,t}\right) = \frac{P\left(R_{1,t} \geq CoVaR^{U,\alpha}_{(1|2U,t)}\right) - P\left(R_{1,t} \geq CoVaR^{U,\alpha}_{(1|2U,t)}, R_{2,t} \geq VaR^{U,\beta}_{2,t}\right)}{1 - P(R_{2,t} \geq VaR^{U,\beta}_{2,t})} = \frac{F_{1,t}\left(CoVaR^{U,\alpha}_{(1|2U,t)}|\mathcal{F}_{t-1};\theta_1\right) - C_t\left(F_{1,t}\left(CoVaR^{U,\alpha}_{(1|2U,t)}|\mathcal{F}_{t-1};\theta_1\right), 1-\beta|\mathcal{F}_{t-1};\theta_c\right)}{\beta} \tag{11}$$

$$P\left(R_{1,t} \leq CoVaR^{D,\alpha}_{(1|2U,t)} \middle| R_{2,t} \geq VaR^{U,\beta}_{2,t}\right) = \frac{P\left(R_{1,t} \leq CoVaR^{D,\alpha}_{(1|2U,t)}\right) - P\left(R_{1,t} \leq CoVaR^{D,\alpha}_{(1|2U,t)}, R_{2,t} \geq VaR^{U,\beta}_{2,t}\right)}{1 - P(R_{2,t} \geq VaR^{U,\beta}_{2,t})} = \frac{F_{1,t}\left(CoVaR^{D,\alpha}_{(1|2U,t)}|\mathcal{F}_{t-1};\theta_1\right) - C_t\left(F_{1,t}\left(CoVaR^{D,\alpha}_{(1|2U,t)}|\mathcal{F}_{t-1};\theta_1\right), 1-\beta|\mathcal{F}_{t-1};\theta_c\right)}{\beta} \tag{12}$$

$$P\left(R_{1,t} \geq CoVaR^{U,\alpha}_{(1|2D,t)} \middle| R_{2,t} \leq VaR^{D,\beta}_{2,t}\right) = \frac{P\left(R_{1,t} \geq CoVaR^{U,\alpha}_{(1|2D,t)}, R_{2,t} \leq VaR^{D,\beta}_{2,t}\right)}{P(R_{2,t} \leq VaR^{D,\beta}_{2,t})} = \frac{C_t\left(F_{1,t}\left(CoVaR^{U,\alpha}_{(1|2D,t)}|\mathcal{F}_{t-1};\theta_1\right), \beta|\mathcal{F}_{t-1};\theta_c\right)}{\beta} \tag{13}$$

Given the values of α and β, we estimate the $CoVaR^{D,\alpha}_{1|2D,t}$, $CoVaR^{U,\alpha}_{1|2U,t}$, $CoVaR^{D,\alpha}_{1|2U,t}$, and $CoVaR^{U,\alpha}_{1|2D,t}$ by solving the following equations based on the bisection method.

$$C_t\left(F_{1,t}\left(CoVaR^{D,\alpha}_{(1|2D,t)}|\mathcal{F}_{t-1}; \theta_1\right), \beta|\mathcal{F}_{t-1}; \theta_c\right) - \alpha\beta = 0 \tag{14}$$

$$F_{1,t}\left(CoVaR^{U,\alpha}_{(1|2U,t)}|\mathcal{F}_{t-1};\theta_1\right)-C_t\left(F_{1,t}\left(CoVaR^{U,\alpha}_{(1|2U,t)}|\mathcal{F}_{t-1};\theta_1\right),1-\beta|\mathcal{F}_{t-1};\theta_c\right)+\alpha\beta-\beta=0 \quad (15)$$

$$F_{1,t}\left(CoVaR^{D,\alpha}_{(1|2U,t)}|\mathcal{F}_{t-1};\theta_1\right)-C_t\left(F_{1,t}\left(CoVaR^{D,\alpha}_{(1|2U,t)}|\mathcal{F}_{t-1};\theta_1\right),1-\beta|\mathcal{F}_{t-1};\theta_c\right)-\alpha\beta=0 \quad (16)$$

$$C_t\left(F_{1,t}\left(CoVaR^{U,\alpha}_{(1|2D,t)}|\mathcal{F}_{t-1};\theta_1\right),\beta|\mathcal{F}_{t-1};\theta_c\right)+\alpha\beta-\beta=0 \quad (17)$$

MEASURING RISK SPILLOVER

Following hypotheses are tested to investigate the extreme risk spillover from uncertainty factors to the US travel & leisure indices:

Hypothesis 1: Downside CoVaR of the given travel & leisure index given the extreme downward movements in the uncertainty factor is significantly different from the downside VaR of the travel & leisure index. This will help to analyze if the extreme decline in values of uncertainty factor significantly influences the downside risk in travel & leisure index.

$H_{01}: CoVaR^{D,\alpha}_{(1|2D)} = VaR^{D,\alpha}_1$

$H_{11}: CoVaR^{D,\alpha}_{(1|2D)} < VaR^{D,\alpha}_1$

Hypothesis 2: Downside CoVaR of the given travel & leisure index given the extreme upward movements in the uncertainty factor is significantly different from the downside VaR of the travel & leisure index. This will help to analyze if the extreme increase in values of uncertainty factor significantly influences the downside risk in travel & leisure index.

$H_{02}: CoVaR^{D,\alpha}_{(1|2U)} = VaR^{D,\alpha}_1$
$H_{12}: CoVaR^{D,\alpha}_{(1|2U)} < VaR^{D,\alpha}_1$

Hypothesis 3: Upside CoVaR of the given travel & leisure index given the extreme downward movements in the uncertainty factor is significantly different from the upside VaR of the travel & leisure index. This will help to analyze if the extreme decline in values of uncertainty factor significantly influences the upside risk in travel & leisure index.

$H_{03}: CoVaR^{U,\alpha}_{(1|2D)} = VaR^{U,\alpha}_1$

$H_{13}: CoVaR^{U,\alpha}_{(1|2D)} > VaR^{U,\alpha}_1$

Hypothesis 4: Upside CoVaR of the given travel & leisure index given the extreme upward movements in the uncertainty factor is significantly different from the upside VaR of the travel & leisure index. This will help to analyze if the extreme up-move in values of uncertainty factor significantly influences the upside risk in travel & leisure index.

$H_{04}: CoVaR^{U,\alpha}_{(1|2U)} = VaR^{U,\alpha}_1$

$$H_{14}: CoVaR^{U,\alpha}_{(1|2U)} > VaR^{U,\alpha}_{1}$$

We also analyze the validity of the existence of asymmetry in the CoVaR estimates by testing the following alternative hypotheses:

Hypothesis 5: The travel & leisure index's downside risk increases by larger magnitude than the upside risk when we observe extreme upward movements in uncertainty factor.

$$H_{15}: \frac{CoVaR^{D,\alpha}_{(1|2U)}}{VaR^{D,\alpha}_{1}} > \frac{CoVaR^{U,\alpha}_{(1|2U)}}{VaR^{U,\alpha}_{1}}$$

Hypothesis 6: The travel & leisure index's downside risk increases by larger magnitude than the upside risk when we observe extreme upward and downward changes in uncertainty factor.

$$H_{16}: \frac{CoVaR^{D,\alpha}_{(1|2U)}}{VaR^{D,\alpha}_{1}} > \frac{CoVaR^{U,\alpha}_{(1|2D)}}{VaR^{U,\alpha}_{1}}$$

Following Mensi et al. (2017), we test these hypotheses using Kolmogorov-Smirnov (KS) test.

DATA AND PRELIMINARY ANALYSIS

DATA

We consider daily data of Dow Jones US Small Cap Travel & Leisure index, Dow Jones US Mid Cap Travel & Leisure index, Dow Jones US Large Cap Travel & Leisure index and Dow Jones US Travel & Leisure index for a period from 15-08-2013 to 13-01-2021. The availability of the data determines the choice of the sample. We use DTLSCAP, DTLMCAP, DTLLCAP and DTL to represent Dow Jones US Small Cap Travel & Leisure index, Dow Jones US Mid Cap Travel & Leisure index, Dow Jones US Large Cap Travel & Leisure index and Dow Jones US Travel & Leisure index. The data for the DTLSCAP, DTLMCAP and DTLLCAP indices are available from 15-08-2013 onward. These indices are considered to analyze if the uncertainty variables react differently to small cap, mid cap and large cap US travel & leisure stocks. We consider the CBOE VIX as an estimate of financial market uncertainty (Akdağ et al., 2019), the CBOE OVX as an estimate uncertainty in crude oil market and EPU (Baker et al., 2016) as an estimate of economic policy uncertainty. We use change in uncertainties for further analysis. The Bloomberg database is used to collect all the data. We estimate the daily logarithmic returns using price ($P_{i,t}$) of travel & leisure indices related to time t as:

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$$

PRELIMINARY ANALYSIS

The summary statistics of the returns of the travel & leisure indices and uncertainty factors are given in Table 1.

Table 1. Descriptive Statistics

	DTLSCAP	DTLMCAP	DTLLCAP	DTL	EPU	VIX	OVX
Mean	0.050	0.030	0.038	0.039	0.081	0.004	0.007
Stdev	1.503	1.861	1.287	1.394	54.948	1.901	5.796
Skewness	-1.385	-1.384	-0.692	-1.029	0.143	2.920	5.074
Kurtosis	32.511	27.166	26.404	28.125	7.656	42.748	249.823
SW	0.797$^{\#}$	0.786$^{\#}$	0.832$^{\#}$	0.805$^{\#}$	0.935$^{\#}$	0.733$^{\#}$	0.308$^{\#}$
Q(20)	147.501$^{\#}$	171.811$^{\#}$	205.447$^{\#}$	180.997$^{\#}$	424.229$^{\#}$	164.370$^{\#}$	303.580$^{\#}$
ARCH(10)	711.590$^{\#}$	798.340$^{\#}$	648.935$^{\#}$	667.151$^{\#}$	416.592$^{\#}$	498.680$^{\#}$	678.930$^{\#}$
ADF	-43.921$^{\#}$	-39.510$^{\#}$	-45.820$^{\#}$	-43.678$^{\#}$	-70.685$^{\#}$	-52.144$^{\#}$	-40.800$^{\#}$

Note: # means significant at 1% level of significance. The SW, Q(20), ARCH(10) and ADF represent the Shapiro-Wilk test statistic for the test of normality, Ljung-Box test statistic for the test of joint autocorrelation up to 20 lags, LM ARCH test of heteroscedasticity up to 10 lags and Augmented Dickey-Fuller test of unit root respectively. Kurtosis refers to excess kurtosis. The DTLSCAP, DTLMCAP, DTLLCAP and DTL to represent Dow Jones US Small Cap Travel & Leisure index, Dow Jones US Mid Cap Travel & Leisure index, Dow Jones US Large Cap Travel & Leisure index and Dow Jones US Travel & Leisure index.

On average, the travel & leisure stock indices provide positive returns during the study period. The DTLMCAP is highly volatile followed by DTLSCAP and DTLLCAP indices. The returns of all travel & leisure stock indices are negatively skewed and exhibit significant excess kurtosis as excess kurtosis is greater than 0. All of the series taken into consideration are non-normal, according to the significant Shapiro-Wilk (SW) statistic. The significant Ljung-Box statistic (Q(20)) for all the series highlight that these series exhibit significant autocorrelation and suitable ARMA(p,q) model needs to be used to capture the series' autocorrelations. The significant values of LM ARCH statistic up to 10 lags indicate the significant heteroscedasticity in all the series and need to be captured using the appropriate volatility model. The significant values of Augmented Dickey-Fuller statistic support the evidence of the stationarity of the given series.

RESULTS

ESTIMATION OF THE MARGINAL MODELS

The findings from the preliminary analysis indicate the presence of significant autocorrelation and heteroscedasticity in all the series. To capture the significant autocorrelation and heteroscedasticity in the given series, we consider selecting the suitable model from the ARMA(p,q)-GARCH family models by comparing Akaike information criterion (AIC) of ARMA(p,q)-GARCH(1,1), ARMA(p,q)-GJR-GARCH(1,1) and ARMA(p,q)-EGARCH(1,1) models with normal distribution, Student-t distribution and generalized error distribution (GED). We discover ARMA(1,1) as the optimal model for all the given series except for EPU changes. For EPU changes, the ARMA(1,0) is an appropriate model. We also find GJR-GARCH(1,1) with Student-t distribution as appropriate volatility model. Accordingly, we use the suitable ARMA(p,q)-GJR-GARCH(1,1) model with t distribution to estimate the marginal models. Table 2 reports the parameter estimates and diagnostics of the models (see equations (1) and (2)). Except for EPU changes, for all other series, the $\alpha+\beta$ is near to 1 indicating persistent nature of volatility shocks for all other series except for EPU changes. Lower and significant values of ν (degree of freedom coefficient) indicate the non-normal distribution of the marginal model's residuals. The significant and positive value of γ reveals the leverage effect associated with the US travel & leisure indices returns suggesting that negative shocks make returns on travel & leisure indices more volatile. According to the insignificant Ljung-Box statistic (Q(20) and Qs(20)), the chosen models effectively describe the dynamics of the given series. Furthermore, the ARCH(10) statistic suggests that the variance model effectively accounts for the heteroscedasticity associated with the series.

Table 2. Parameter Estimates of Marginal Model

	DTLSCAP	DTLMCAP	DTLLCAP	DTL	EPU	VIX	OVX
μ_0	$0.062^{\#}$	$0.072^{\#}$	$0.067^{\#}$	$0.073^{\#}$	$-0.584^{\#}$	$-0.014^{\#}$	-0.039^{*}
	(0.021)	(0.025)	(0.019)	(0.019)	(0.161)	(0.002)	(0.020)
θ_1	-0.014	0.018	$-0.990^{\#}$	$-0.985^{\#}$	$0.123^{\dagger}$	$0.862^{\#}$	$0.731^{\#}$
	(0.023)	(0.024)	(0.026)	(0.025)	(0.067)	(0.026)	(0.071)
δ_1	$-0.045^{\dagger}$	$-0.048^{\dagger}$	$0.995^{\#}$	$0.996^{\#}$	-	$-0.993^{\#}$	$-0.765^{\#}$
	(0.024)	(0.026)	(0.004)	(0.004)	-	(0.001)	(0.064)
ω	$1.248^{\#}$	$1.510^{\#}$	0.453	0.486	$2955.152^{\#}$	1.168^{*}	1.351^{*}
	(0.385)	(0.569)	(0.366)	(0.720)	(4.186)	(0.575)	(0.601)
α	0.016	0.025	0.044^{*}	0.031	$0.243^{\#}$	$0.427^{\#}$	$0.203^{\#}$
	(0.017)	(0.016)	(0.020)	(0.019)	(0.048)	(0.081)	(0.044)
β	$0.881^{\#}$	$0.858^{\#}$	$0.820^{\#}$	$0.840^{\#}$	0.257	$0.682^{\#}$	$0.823^{\#}$
	(0.026)	(0.026)	(0.026)	(0.022)	(0.182)	(0.037)	(0.036)
γ	$0.115^{\#}$	$0.132^{\#}$	$0.135^{\#}$	$0.137^{\#}$	-0.148	$-0.471^{\#}$	$-0.173^{\#}$
	(0.024)	(0.030)	(0.032)	(0.031)	(0.094)	(0.082)	(0.039)
ν	$7.537^{\#}$	$7.300^{\#}$	$7.118^{\#}$	$6.658^{\#}$	$3.866^{\#}$	$3.331^{\#}$	$4.105^{\#}$
	(1.239)	(1.188)	(1.110)	(1.059)	(0.369)	(0.273)	(0.440)
LLF	-2755.706	-3031.586	-2537.941	-2591.228	-9462.052	-2834.953	-3548.129
AIC	2.969	3.264	2.741	2.798	10.159	3.056	3.820
Q(20)	25.830	19.179	20.028	20.378	22.935	21.047	23.612
Qs(20)	22.994	15.943	7.874	8.432	7.903	14.596	2.714
ARCH(10)	2.118	1.353	0.501	0.726	0.435	0.270	0.220

Note: #, * and † mean significant at 1%, 5% and 10% levels of significance respectively. The terms in the parenthesis represent standard errors.

COPULA MODEL ESTIMATION

We capture the dependence in the standardized residuals of the marginal models using suitable time-varying copula. Table 3 reports the Kendall tau (τ, static dependence estimate) and the Akaike information criterion (AIC) of the five time-varying copula models for different travel & leisure indices and uncertainties pairs. The findings based on τ assist us in determining whether or not the relationship between the returns of the US travel & leisure indices and uncertainty factors is statistically significant. The findings show that there is a highly significant negative relationship (at 1% level) between travel & leisure indices returns and VIX and OVX. In comparison to OVX, VIX has a stronger link. However, the travel & leisure stock indices are positively associated with EPU except for the negative correlation between the mid-cap travel & leisure stock index and EPU. This static relationship is relatively weak. Next, we examine the evolution of the dependence structure between the travel & leisure indices and uncertainties based on the best-fit copula model.

Table 3. Copula Estimates

	τ	TV-Normal	TV-Clayton	TV-Gumbel	TV-SJC	TV-t
DTLSCAP-EPU	0.038^{*}	-5.851	-6.231	-11.862	5.214	-37.636
DTLSCAP-VIX	$-0.640^{\#}$	-984.882	0.151	0.229	158.187	-1042.218
DTLSCAP-OVX	$-0.277^{\#}$	-160.223	0.065	-0.123	74.966	-249.360
DTLMCAP-EPU	$-0.123^{\#}$	-7.610	-4.128	-12.999	8.086	-45.877
DTLMCAP-VIX	$-0.661^{\#}$	-1024.593	0.146	0.228	158.415	-1173.729
DTLMCAP-OVX	$-0.295^{\#}$	-172.147	0.064	-0.182	75.178	-325.002
DTLLCAP-EPU	$0.064^{\#}$	-2.482	-3.914	-3.779	3.957	-4.022
DTLLCAP-VIX	$-0.682^{\#}$	-1160.072	0.162	0.199	168.681	-1290.031
DTLLCAP-OVX	$-0.260^{\#}$	-159.958	0.063	-0.050	75.077	-254.619
DTL-EPU	0.014	-2.989	-3.740	-11.598	5.823	-28.504
DTL-VIX	$-0.702^{\#}$	-1255.386	0.166	0.220	172.492	-1382.345
DTL-OVX	$-0.239^{\#}$	-177.533	0.067	-0.094	78.346	-264.521

Note: # and * mean significant at 1% and 5% levels of significance respectively.

For modeling the multivariate distribution related to the US travel & leisure indices and uncertainties, we identify a suitable time-varying copula considering the smallest value of AIC (highlighted in bold) (see Table 3). The results show that the time-varying t-copula is the best copula for approximating the dependence structure between the travel & leisure indices and uncertainty factors. This demonstrates that there is no asymmetric connection between daily variations in uncertainty factors and the US travel & leisure indices returns.

Plots given in Figure 1 illustrate the dynamic nature of dependence between the travel & leisure indices returns and variations in uncertainty factors for the sample period. The DTLSCAP, DTLMCAP and DTLLCAP indices are showing a nearly similar relationship with the given uncertainty variable. The association between travel & leisure indices returns and VIX and OVX is primarily negative. However, the association between travel & leisure indices and EPU fluctuates between positive and negative values. Compared to the degree of dependence between travel & leisure indices returns and EPU, the degree of dependence between travel & leisure indices returns and changes in VIX and OVX is considerably higher. These results are in line with the whole sample dependence estimates as given in Table 3.

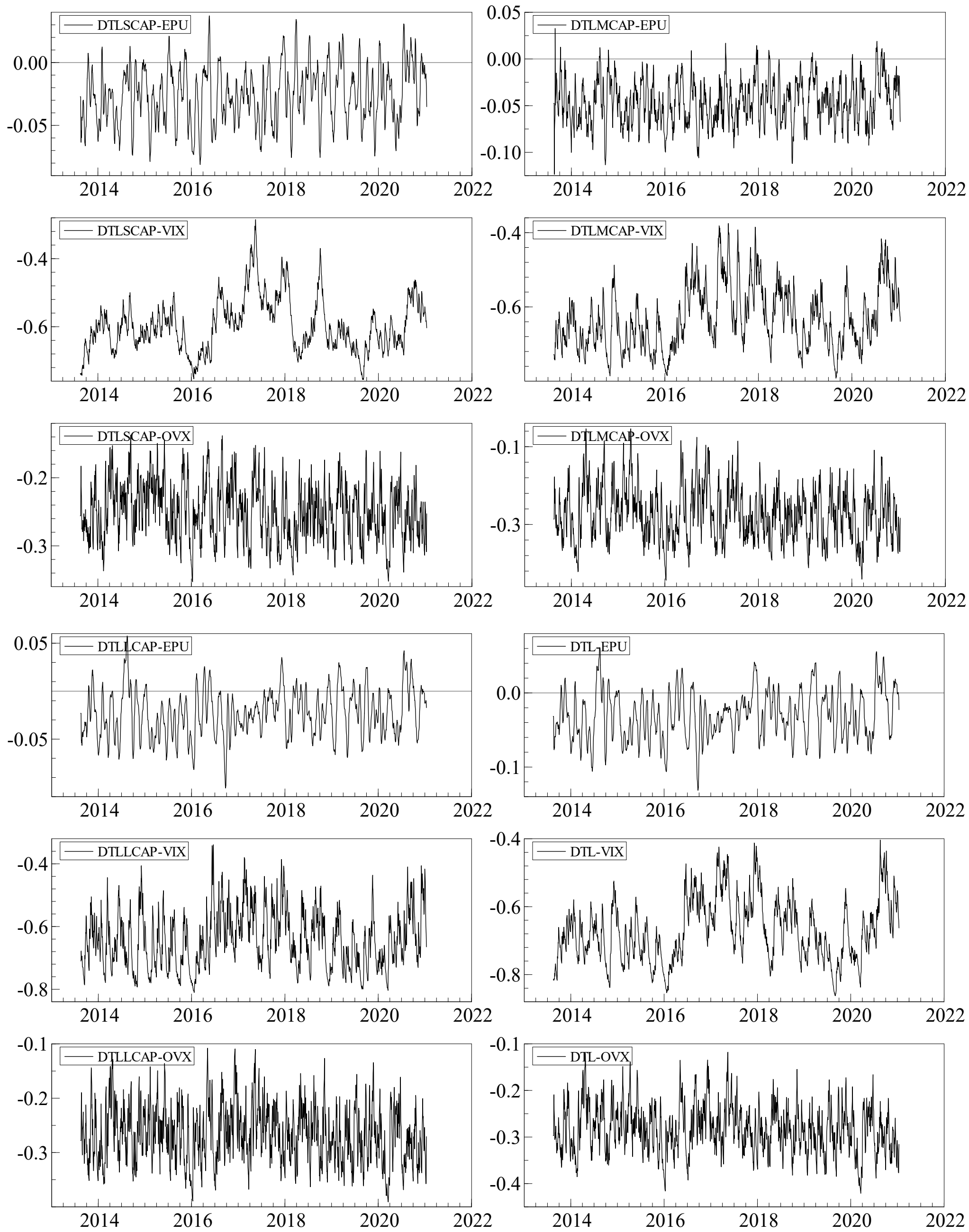

Figure 1. Dependence Measure Based on Time-Varying T-Copula

The volatility of the time-varying dependence measure is the lowest for the travel & leisure stock returns and VIX pair. The small-cap travel & leisure index exhibits lower volatility in the relationship with the uncertainty variables in comparison to mid-cap and large-cap travel & leisure indices. The average value of the time-varying dependence between the US travel & leisure index returns and the VIX changes is the greatest followed by the average value of dependence with respect to OVX changes. The average dependence between the travel & leisure indices and EPU is the lowest. It is clear that in 2020, the degree of dependency between VIX changes and returns of travel & leisure indices is primarily declining with an upward trend (negative estimates) and with wider fluctuations.

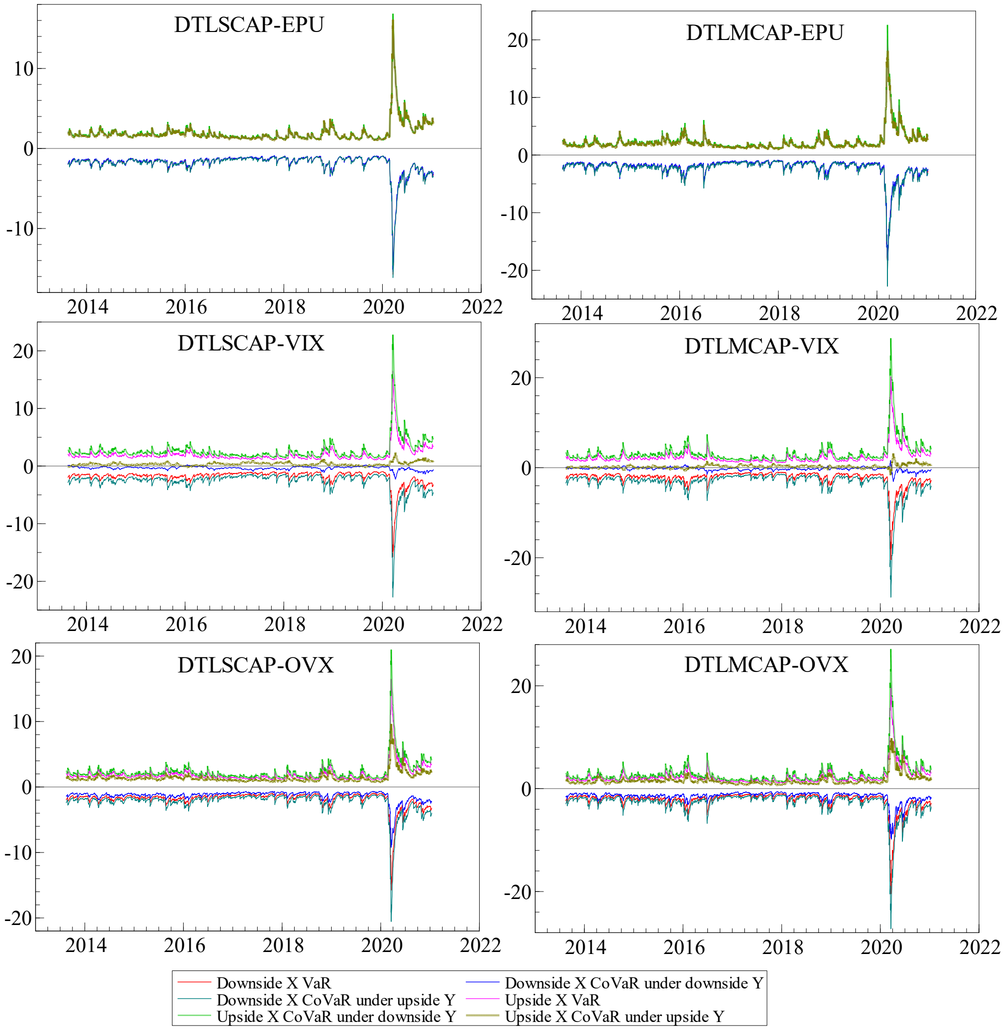

Figure 2.1. CoVaR and VaR Estimates

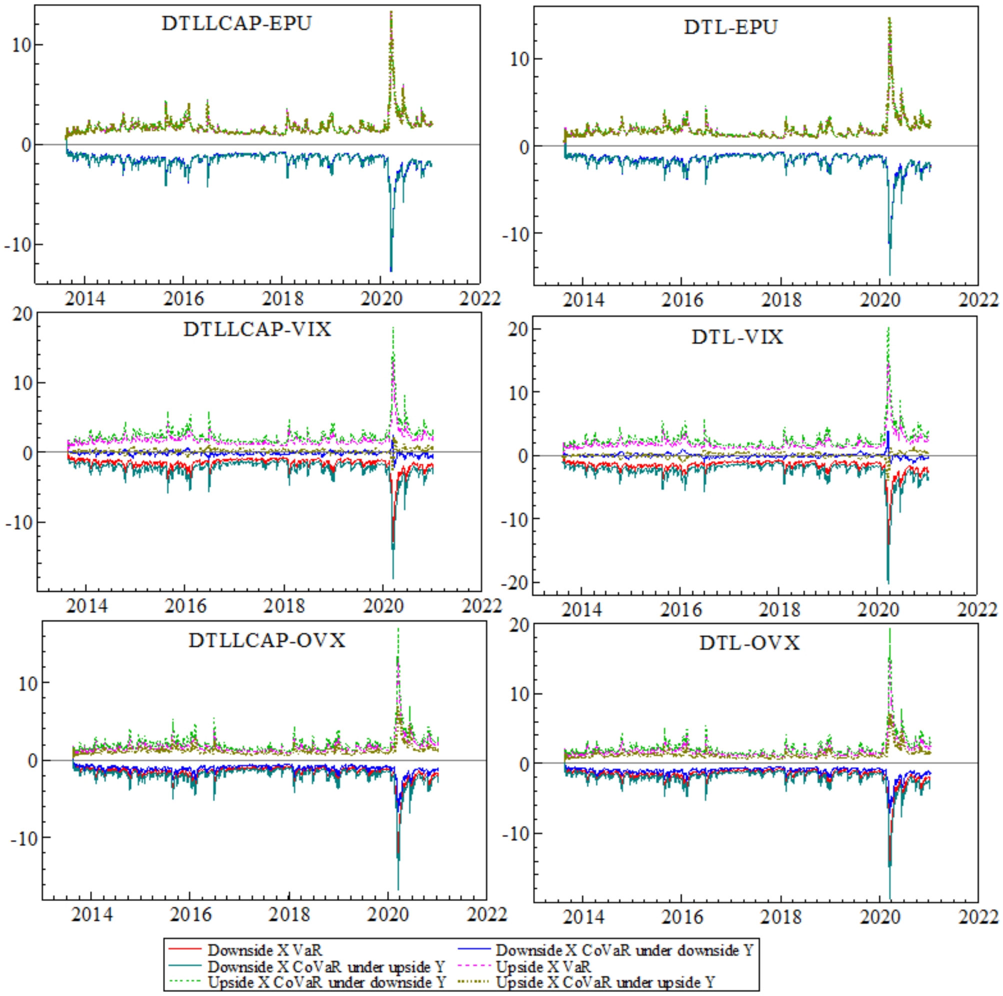

Figure 2.2. CoVaR and VaR Estimates

RISK SPILLOVER ANALYSIS

In this section, we estimate CoVaRs using equations (6) to (9) as the extreme risk of the US travel & leisure indices given the extreme risk in uncertainty factors. The trend of the downside and upside 5% and 95% VaR and CoVaR estimations are shown in Figures 2.1 and 2.2. The results of the plots show that the trajectory of risk in DTLSCAP, DTLMCAP and DTLLCAP indices appear to be nearly the same with spikes in risk values during March-May 2020 (COVID-19 period) indicating the evident impact of a sudden rise in COVID-19 cases. This shows that there is evidence of concern about the uncertainty shocks spreading to the US travel & leisure market. Moreover, for each of the travel & leisure indices considered, the degrees of risk estimations vary over time. The VaR estimates of the DTLMCAP index are larger than the corresponding VaR values of the DTLSCAP and DTLLCAP indices. This indicates that the stocks under DTLMCAP index are riskier than stocks under DTLSCAP and DTLLCAP indices in both bullish and bearish market trends. The findings also show that stocks under DTLLCAP index consistently exhibit decreased risk than stocks under DTLSCAP and DTLMCAP indices. The level of the downside CoVaR values for a specific index of the US travel & leisure industry is persistently high with up moves in the uncertainty factors, showing that the increasing uncertainties are worsening the downside risk of the stocks in the US travel & leisure industry. In contrast, compared to the upside VaR of the considered travel & leisure indices, the level of the corresponding upside CoVaR values given the extreme downward changes in the uncertainty factors is generally high. This suggests that the share price of the firms in the US travel & leisure industry exhibit upward movements with a sharp decrease in the uncertainty factors. These findings are similar for the DTLSCAP, DTLMCAP and DTLLCAP indices. The impact of financial market uncertainty (VIX) is much higher on the upside and downside risk of the US travel & leisure indices followed by the influence of OVX and EPU. This suggests that the uncertainty in financial market and crude oil prices have a stronger impact on the risk of the US travel & leisure industry equities than the economic policy uncertainty.

Table 4 presents the Kolmogorov-Smirnov (KS) statistic with p-values to determine whether there is a significant divergence between the VaR and CoVaR estimates in order to assess risk spillover from uncertainty factors. Columns 2 to 5 in Table 4 display the KS statistic with p-value to test Hypotheses 1 to 4 respectively. The findings support the rejection of Hypotheses 2 and 3 at conventional significance levels for all travel & leisure indices and uncertainty factor pairs. Rejection of Hypothesis 2 indicates that for all the pairs, the travel & leisure index's downside CoVaRs given increased uncertainty factor's value are much smaller (larger CoVaR's magnitude but with negative sign) than the comparable downside VaR of the travel & leisure index. This shows that an excessive rise in EPU, VIX and OVX has a detrimental impact on the performance of the US travel & leisure industry. This shows that there is a significant downside risk spillover due to the sharp increase in uncertainty factors to the given US travel & leisure indices. For VIX, the greater magnitude of the KS statistic shows a more robust affirmation of risk spillover to the US travel & leisure industry from VIX. The lower magnitude of the KS statistic for EPU suggests that risk spillover from EPU is having a smaller impact on stock indices for the US travel & leisure industry. Rejection of Hypothesis 3 indicates that for all the pairs, the travel & leisure index's upside CoVaRs given decreased uncertainty factor's value are much larger than the comparable upside VaR of the travel & leisure index. This confirms the findings that the decline in the uncertainties values has a major impact on the rise in returns of the US travel & leisure indices. This shows that the extreme decline in uncertainty factors exhibits upside risk spillover effect on the given US travel & leisure indices. For EPU, the findings confirm the significant upside risk spillover for the large-cap stock index and the benchmark travel & leisure index at 5% level. Overall, the risk spillover effects to travel & leisure stock indices are higher for VIX and OVX than the effect of EPU. The non-rejection of Hypotheses 1 and 4 states that there is no sign of downward and upward risk spillover to travel & leisure stock indices from a decrease (increase) in EPU, VIX, and OVX.

Table 4. Risk Spillover Tests

	Downside Risk Spillover		Upside risk Spillover	
	$H_{01}: CoVaR^{D,\alpha}_{(1\|2D)} = VaR^{D,\alpha}_{1}$ $H_{11}: CoVaR^{D,\alpha}_{(1\|2D)} < VaR^{D,\alpha}_{1}$	$H_{02}: CoVaR^{D,\alpha}_{(1\|2U)} = VaR^{D,\alpha}_{1}$ $H_{12}: CoVaR^{D,\alpha}_{(1\|2U)} < VaR^{D,\alpha}_{1}$	$H_{03}: CoVaR^{U,\alpha}_{(1\|2D)} = VaR^{U,\alpha}_{1}$ $H_{13}: CoVaR^{U,\alpha}_{(1\|2D)} > VaR^{U,\alpha}_{1}$	$H_{04}: CoVaR^{U,\alpha}_{(1\|2U)} = VaR^{U,\alpha}_{1}$ $H_{14}: CoVaR^{U,\alpha}_{(1\|2U)} > VaR^{U,\alpha}_{1}$
DTLScap-EPU	0.002 [0.995]	$0.053^{\#}$ [0.006]	$0.051^{\#}$ [0.007]	0.001 [0.998]
DTLScap-VIX	0.000 [1.000]	$0.971^{\#}$ [0.000]	$0.490^{\#}$ [0.000]	0.000 [1.000]
DTLScap-OVX	0.000 [1.000]	$0.474^{\#}$ [0.000]	$0.306^{\#}$ [0.000]	0.000 [1.000]
DTLMcap-EPU	0.001 [0.999]	$0.084^{\#}$ [0.000]	$0.064^{\#}$ [0.000]	0.001 [0.998]
DTLMcap-VIX	0.000 [1.000]	$0.966^{\#}$ [0.000]	$0.438^{\#}$ [0.000]	0.000 [1.000]
DTLMcap-OVX	0.000 [1.000]	$0.474^{\#}$ [0.000]	$0.272^{\#}$ [0.000]	0.000 [1.000]
DTLLcap-EPU	0.001 [0.998]	$0.053^{\#}$ [0.006]	0.044^{*} [0.026]	0.002 [0.991]
DTLLcap-VIX	0.000 [1.000]	$0.978^{\#}$ [0.000]	$0.446^{\#}$ [0.000]	0.000 [1.000]
DTLLcap-OVX	0.000 [1.000]	$0.452^{\#}$ [0.000]	$0.279^{\#}$ [0.000]	0.000 [1.000]
DTL-EPU	0.001 [0.999]	$0.059^{\#}$ [0.001]	0.046^{*} [0.018]	0.003 [0.987]
DTL-VIX	0.000 [1.000]	$0.977^{\#}$ [0.000]	$0.432^{\#}$ [0.000]	0.000 [1.000]
DTL-OVX	0.000 [1.000]	$0.451^{\#}$ [0.000]	$0.278^{\#}$ [0.000]	0.000 [1.000]

Note: # and * mean significant at 1% and 5% levels of significance respectively. The terms in square braces [.] represent p-values.

Table 5. Asymmetric Risk Spillover

	$H_{05}: \frac{CoVaR^{D,\alpha}_{(1\|2U)}}{VaR^{D,\alpha}_{1}} = \frac{CoVaR^{U,\alpha}_{(1\|2U)}}{VaR^{U,\alpha}_{1}}$ $H_{15}: \frac{CoVaR^{D,\alpha}_{(1\|2U)}}{VaR^{D,\alpha}_{1}} > \frac{CoVaR^{U,\alpha}_{(1\|2U)}}{VaR^{U,\alpha}_{1}}$	$H_{06}: \frac{CoVaR^{D,\alpha}_{(1\|2U)}}{VaR^{D,\alpha}_{1}} = \frac{CoVaR^{U,\alpha}_{(1\|2D)}}{VaR^{U,\alpha}_{1}}$ $H_{16}: \frac{CoVaR^{D,\alpha}_{(1\|2U)}}{VaR^{D,\alpha}_{1}} > \frac{CoVaR^{U,\alpha}_{(1\|2D)}}{VaR^{U,\alpha}_{1}}$
DTLScap-EPU	*$0.559^{\#}$* *[0.000]*	*0.021* *[0.440]*
DTLScap-VIX	*$0.838^{\#}$* *[0.000]*	*0.000* *[1.000]*
DTLScap-OVX	*$0.726^{\#}$* *[0.000]*	*0.000* *[1.000]*
DTLMcap-EPU	*$0.558^{\#}$* *[0.000]*	*$0.084^{\#}$* *[0.000]*
DTLMcap-VIX	*$0.817^{\#}$* *[0.000]*	*0.000* *[1.000]*
DTLMcap-OVX	*$0.722^{\#}$* *[0.000]*	*0.000* *[1.000]*
DTLLcap-EPU	*$0.519^{\#}$* *[0.000]*	*0.047^{*}* *[0.015]*
DTLLcap-VIX	*$0.801^{\#}$* *[0.000]*	*0.000* *[1.000]*
DTLLcap-OVX	*$0.719^{\#}$* *[0.000]*	*0.001* *[0.999]*
DTL-EPU	*$0.514^{\#}$* *[0.000]*	*$0.056^{\#}$* *[0.003]*
DTL-VIX	*$0.809^{\#}$* *[0.000]*	*0.000* *[1.000]*
DTL-OVX	*$0.711^{\#}$* *[0.000]*	*0.001* *[0.999]*

Note: # and * mean significant at 1% and 5% levels of significance respectively. The terms in square braces [.] represent p-values.

The KS test statistic and p-values for Hypotheses 5 and 6 are shown in Table 5 to assess if an asymmetric risk spillover effect exists. The rejection of Hypothesis 5 indicates that the given travel & leisure index's downside risk increases by a larger magnitude than the upside risk when we observe extreme upward movements in the uncertainty factor indicating that the extent of downside risk spillover to the travel & leisure indices is markedly larger than the extent of upside risk spillover from upward movements in uncertainty factors. More specifically, the asymmetric downside risk spillover effects conditional on upward changes in VIX and OVX are significantly larger than the impact of upward changes in EPU. The rejection of Hypotheses 6 for mid-cap, large-cap and benchmark travel & leisure indices in relation to EPU indicates that the mid-cap, large-cap and benchmark travel & leisure indices' downside risk increases by a larger magnitude than the upside risk when we observe extreme upward and downward changes in EPU. This indicates that for mid-cap, large-cap and benchmark indices, the magnitude of downside risk spillover given extreme upward movement in EPU is higher than the upside risk spillover given extreme downward movement in EPU. The results show that risk spillover to the US travel & leisure industry from uncertainty factors is pro-cyclical and asymmetric, having a more noticeable effect throughout periods of extreme downturns. with a more noticeable impact during periods of downswing.

ROBUSTNESS ANALYSIS

To undertake robustness analysis, we estimate the joint density based on time-varying Normal copula and repeat the whole analysis. The results of risk spillover based on the KS test are shown in Table 6.1. The results are remarkably similar to what we obtained for the dynamic t-copula. There is a minor difference in the findings. First, there is no evidence of significant downside risk spillover from extreme upward EPU to travel & leisure mid-cap index. Also, there is no indication of upside risk spillover from extreme downward EPU to travel & leisure benchmark index and large-cap index. The results for asymmetric risk spillover are shown in Table 6.2. Here also, the findings are nearly the same as we find in Table 5 with few exceptions. The results show that risk spillover effects are more robust if the dynamic dependence is estimated using optimal copula.

Table 6.1. Robustness Analysis

	Downside Risk Spillover		**Upside risk Spillover**	
	$H_{01}: CoVaR^{D,\alpha}_{(1\|2D)} = VaR^{D,\alpha}_{1}$ $H_{11}: CoVaR^{D,\alpha}_{(1\|2D)} < VaR^{D,\alpha}_{1}$	$H_{02}: CoVaR^{D,\alpha}_{(1\|2U)} = VaR^{D,\alpha}_{1}$ $H_{12}: CoVaR^{D,\alpha}_{(1\|2U)} < VaR^{D,\alpha}_{1}$	$H_{03}: CoVaR^{U,\alpha}_{(1\|2D)} = VaR^{U,\alpha}_{1}$ $H_{13}: CoVaR^{U,\alpha}_{(1\|2D)} > VaR^{U,\alpha}_{1}$	$H_{04}: CoVaR^{U,\alpha}_{(1\|2U)} = VaR^{U,\alpha}_{1}$ $H_{14}: CoVaR^{U,\alpha}_{(1\|2U)} > VaR^{U,\alpha}_{1}$
DTLScap-EPU	*0.001* *[0.999]*	*0.053*$^{\#}$ *[0.005]*	*0.048** *[0.013]*	*0.001* *[0.999]*
DTLScap-VIX	*0.000* *[1.000]*	*0.971*$^{\#}$ *[0.000]*	*0.490*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLScap-OVX	*0.000* *[1.000]*	*0.474*$^{\#}$ *[0.000]*	*0.306*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLMcap-EPU	*0.137*$^{\#}$ *[0.000]*	*0.003* *[0.981]*	*0.235*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLMcap-VIX	*0.000* *[1.000]*	*0.961*$^{\#}$ *[0.000]*	*0.604*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLMcap-OVX	*0.003* *[0.987]*	*0.330*$^{\#}$ *[0.000]*	*0.450*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLLcap-EPU	*0.000* *[1.000]*	*0.205*$^{\#}$ *[0.000]*	*0.000* *[1.000]*	*0.153*$^{\#}$ *[0.000]*
DTLLcap-VIX	*0.000* *[1.000]*	*0.988*$^{\#}$ *[0.000]*	*0.334*$^{\#}$ *[0.000]*	*0.004* *[0.974]*
DTLLcap-OVX	*0.000* *[1.000]*	*0.574*$^{\#}$ *[0.000]*	*0.156*$^{\#}$ *[0.000]*	*0.004* *[0.974]*
DTL-EPU	*0.000* *[1.000]*	*0.197*$^{\#}$ *[0.000]*	*0.001* *[0.999]*	*0.124*$^{\#}$ *[0.000]*
DTL-VIX	*0.000* *[1.000]*	*0.988*$^{\#}$ *[0.000]*	*0.354*$^{\#}$ *[0.000]*	*0.002* *[0.991]*
DTL-OVX	*0.000* *[1.000]*	*0.570*$^{\#}$ *[0.000]*	*0.178*$^{\#}$ *[0.000]*	*0.003* *[0.981]*

Note: # and * mean significant at 1% and 5% levels of significance respectively. The terms in square braces [.] represent p-values.

Table 6.2. Robustness Analysis for Asymmetric Risk Spillover

	$H_{05}: \frac{\boldsymbol{CoVaR^{D,\alpha}_{(1\mid 2U)}}}{\boldsymbol{VaR^{D,\alpha}_{1}}} = \frac{\boldsymbol{CoVaR^{U,\alpha}_{(1\mid 2U)}}}{\boldsymbol{VaR^{U,\alpha}_{1}}}$ $H_{15}: \frac{\boldsymbol{CoVaR^{D,\alpha}_{(1\mid 2U)}}}{\boldsymbol{VaR^{D,\alpha}_{1}}} > \frac{\boldsymbol{CoVaR^{U,\alpha}_{(1\mid 2U)}}}{\boldsymbol{VaR^{U,\alpha}_{1}}}$	$H_{06}: \frac{\boldsymbol{CoVaR^{D,\alpha}_{(1\mid 2U)}}}{\boldsymbol{VaR^{D,\alpha}_{1}}} = \frac{\boldsymbol{CoVaR^{U,\alpha}_{(1\mid 2D)}}}{\boldsymbol{VaR^{U,\alpha}_{1}}}$ $H_{16}: \frac{\boldsymbol{CoVaR^{D,\alpha}_{(1\mid 2U)}}}{\boldsymbol{VaR^{D,\alpha}_{1}}} > \frac{\boldsymbol{CoVaR^{U,\alpha}_{(1\mid 2D)}}}{\boldsymbol{VaR^{U,\alpha}_{1}}}$
DTLScap-EPU	*0.746*$^{\#}$ *[0.000]*	*0.012* *[0.751]*
DTLScap-VIX	*1.000*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLScap-OVX	*1.000*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLMcap-EPU	*0.242*$^{\#}$ *[0.000]*	*0.021* *[0.421]*
DTLMcap-VIX	*1.000*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLMcap-OVX	*0.897*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLLcap-EPU	*0.085*$^{\#}$ *[0.000]*	*0.047** *[0.017]*
DTLLcap-VIX	*0.997*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTLLcap-OVX	*0.849*$^{\#}$ *[0.000]*	*0.003* *[0.987]*
DTL-EPU	*0.128*$^{\#}$ *[0.000]*	*0.058*$^{\#}$ *[0.002]*
DTL-VIX	*1.000*$^{\#}$ *[0.000]*	*0.000* *[1.000]*
DTL-OVX	*0.926*$^{\#}$ *[0.000]*	*0.003* *[0.981]*

Note: # and * mean significant at 1% and 5% levels of significance respectively. The terms in square braces [.] represent p-values.

CONCLUSION, DISCUSSION AND IMPLICATIONS

The study analyzes the dynamic interlinkages between the US travel & leisure industry indices and uncertainty factors related to the financial market (VIX), economic policy (EPU) and crude oil prices (CVIX). We further examine the risk spillover effect from these uncertainty factors to the US travel & leisure indices. We also examine if the risk spillover effects of these uncertainty variables are different for large-cap, mid-cap and small-cap stock indices. Using optimal marginal models and time-varying t-copula, the study captures the dynamics of the series and the dependence structure between the travel & leisure indices and uncertainty factors. We observe a significant negative relationship between the returns of the various US travel & leisure indices and VIX and CVIX. The significant negative relationship shows that the decline in travel & leisure indices returns is attributed to the increased uncertainty in stock market and energy market. Using the results of marginal models and multivariate density based on time-varying t-copula, we estimate CoVaR of the US travel & leisure indices given extreme movements in uncertainties. The finding indicates that the large-cap, mid-cap and small-cap travel & leisure sector stocks experience a homogeneous response to a particular uncertainty variable. We also find convincing results of upside and downside risk spillover to the US travel & leisure industry indices given the extreme downward and upward movements in uncertainty factors. The results also highlight the presence of asymmetric risk spillover effect to the US travel & leisure indices from the given uncertainty factors.

The uncertainty factors possibly are viewed as external characteristics that have a negative influence on consumer psychology, purchasing patterns, and the willingness to utilize travel & leisure services (Dragouni et al., 2016). The risk related to the travel & leisure industry enterprises may rise as a result of an excessive escalation of market uncertainties, which may result in the release of unfavorable news that causes an excessive downward adjustment of forthcoming cash flows and an abnormal increased adjustment to the cost of capital of the enterprise. Additionally, a surge in uncertainty factors may result in a greater necessity for risk management techniques. This could result in additional expenses such as escalated insurance expenses, hedging expenses, and risk compensation expenses (Rejda, 2011). Extremely increased EPU may be detrimental to the operations of travel & leisure related enterprises by negatively affecting demand shocks (Balli et al., 2018). The increased EPU can lead to a drop in free cash flows and profits of travel & leisure industry firms by either increasing the cost of capital or by the decision of reducing the dividend payment (Kumar, 2023), and thereby increasing the risk associated with the travel & leisure industry firms. The results of the current study confirm the findings of Dragouni et al. (2016), Balli et al. (2018) and Kumar (2023) in relation to the importance of increased EPU in increasing the extreme risk of the US travel & leisure industry.

Extremely high levels of uncertainty in the financial markets can have a detrimental effect on consumer psychology and consumption pattern, particularly when it comes to luxury purchases like tourism activities (Dragouni et al., 2016). This has an effect on decreasing the desire for utilizing travel & leisure offerings and services, which therefore lowers the valuation of travel & leisure company stocks (Kumar, 2023). Our results show that the size of the effect of rising uncertainty in financial market (VIX) on the US travel & leisure industry indices is greater than the influence of other uncertainty factors.

Travel & leisure industry has transport and leisure as crucial elements which are heavily reliant on crude oil directly or indirectly (Becken, 2008). Rising crude oil price uncertainty may lead to higher inflation, which may lower travelers' earnings and have an adverse impact on their travel plans, destination choices, and travel expenses. This can adversely influence the cash flows, earnings and cost of capital of the travel & leisure industry firms. Crude oil price shocks might have adverse effect on manufacturing and service costs of firms across various sub-industries under travel & leisure industry. This can possibly have a detrimental effect on the price of tourism-related activities, ultimately affecting the entire travel & leisure industry (Kisswani et al., 2020). Our findings confirm that the extreme shocks to the crude oil prices increase the risk of the US travel & leisure industry stocks.

Our findings provide critical insights for responsible and risk-averse investors and portfolio managers in the US, which may affect their investment assessments and choices as changes in uncertainty factors can have a considerable impact on portfolio returns. These choices entail developing and putting into place frameworks for risk management based on changes in uncertainty factors and by effectively evaluating the co-movement of risk. Investors and portfolio managers can use derivative instruments to conduct hedging strategies and prevent losses in the worth of their holdings as uncertainty levels rise. This suggests that while undertaking trading, investment and asset allocation choices concerning travel & leisure industry stocks, investors should also consider the consequences of heightened uncertainties in a market. The findings related to the asymmetric risk

---

spillover effect have significant ramifications for market players who undertake risk management practices (to effectively offset the risk) and asset allocation practices (to effectively diversify) amid market swings. The findings have consequences for policymakers as well. The results prompt recommendations for US policymakers to develop strategies to support tourism industry including during times of growing uncertainties. When there is heightened uncertainty, the US government should offer economic help to the US travel & leisure industry firms to help them perform better. Additionally, the US policymakers can build an early warning system in relation to the adverse movements in the uncertainty factors and can take appropriate actions to prevent the transmission of shocks from uncertainty factors to the US travel & leisure industry. It is essential, given the significance of the US travel & leisure industry in employment creation and economic growth.

Our study employs a bivariate setup to examine risk spillover from uncertainty factors to the US travel & leisure industry. Future research may take into account a more elaborate multivariate setup to investigate risk spillover effect from uncertainty factors to the US travel & leisure industry. Further study may look into the extreme risk spillover effect to the US travel & leisure industry considering additional uncertainty measures like political uncertainty. Future studies can also consider the influence of heightened uncertainties on earnings and cash flows of the travel & leisure industry businesses.

REFERENCE

Aharon, D. Y. (2020). Sentiment, Confidence and Uncertainty: The Case of Tourism and Leisure Stocks. *Cornell Hospitality Quarterly*, 63(3), 385-398.

Akdağ, S., Kiliç, İ., & Yildirim, H. (2019). Does VIX Scare Stocks of Tourism Companies? *Letters in Spatial and Resource Sciences*, *12*(3), 215-232.

Al-Thaqeb, S. A., Algharabali, B. G., & Alabdulghafour, K. T. (2022). The Pandemic and Economic Policy Uncertainty. *International Journal of Finance & Economics*, *27*(3), 2784-2794.

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring Economic Policy Uncertainty. *The Quarterly Journal of Economics*, *131*(4), 1593-1636.

Balli, F., Shahzad, S. J. H., & Uddin, G. S. (2018). A Tale of Two Shocks: What Do We Learn from the Impacts of Economic Policy Uncertainties on Tourism? *Tourism Management*, *68*, 470-475.

Barrero, J. M., Bloom, N., & Wright, I. (2017). Short and Long Run Uncertainty. (No. w23676), National Bureau of Economic Research.

Becken, S. (2008). Developing Indicators for Managing Tourism in the Face of Peak Oil. *Tourism Management*, *29*(4), 695-705.

Becken, S. (2011). Oil, the Global Economy and Tourism. *Tourism Review*, 66(3), 65-72.

Becken, S., & Lennox, J. (2012). Implications of a Long-Term Increase in Oil Prices for Tourism. *Tourism Management*, *33*(1), 133-142.

Cepni, O., Dogru, T., & Ozdemir, O. (2022). The Contagion Effect of COVID-19-Induced Uncertainty on US Tourism Sector: Evidence from Time-Varying Granger Causality Test. *Tourism Economics*, forthcoming.

Chen, M.-H., Agrusa, J., Krumwiede, D., & Lu, H.-J. (2012). Macroeconomic Influences on Japanese Hotel Stock Returns. *Journal of Hospitality Marketing & Management*, *21*(1), 81-99.

Chen, M.-H., Liao, C.-N., & Huang, S.-S. (2010). Effects of Shifts in Monetary Policy on Hospitality Stock Performance. *The Service Industries Journal*, *30*(2), 171-184.

Cheng, C. H. J., & Chiu, C.-W. J. (2018). How Important are Global Geopolitical Risks to Emerging Countries? *International Economics*, *156*, 305-325.

Council, W. T. a. T. (2020). Global Economic Impact & Trends 2020. WTTC.

De La VIina, L. Y., Hollas, D., Merrifield, J., & Ford, J. (1994). A Principal Components-Based Tourism Activity Index. *Journal of Travel Research*, *32*(4), 37-40.

Demir, E., & Ersan, O. (2018). The Impact of Economic Policy Uncertainty on Stock Returns of Turkish Tourism Companies. *Current Issues in Tourism*, *21*(8), 847-855.

Demir, E., & Gözgör, G. (2018). Does Economic Policy Uncertainty Affect Tourism? *Annals of Tourism Research*, *69*(C), 15-17.

Diebold, F. X., & Yılmaz, K. (2014). On the Network Topology of Variance Decompositions: Measuring the Connectedness of Financial Firms. *Journal of Econometrics*, *182*(1), 119-134.

Dragouni, M., Filis, G., Gavriilidis, K., & Santamaria, D. (2016). Sentiment, Mood and Outbound Tourism Demand. *Annals of Tourism Research*, *60*, 80-96.

Drakos, K. (2004). Terrorism-Induced Structural Shifts in Financial Risk: Airline Stocks in the Aftermath of the September 11th Terror Attacks. *European Journal of Political Economy*, *20*(2), 435-446.

Ersan, O., Akron, S., & Demir, E. (2019). The Effect of European and Global Uncertainty on Stock Returns of Travel and Leisure Companies. *Tourism Economics*, *25*(1), 51-66.

Genc, I. H., Miller, J. R., & Gursoy, D. (2006). The Macroeconomic Environment and Airline Profitability: A Study of us Regional Airlines. *Tourism Analysis*, *11*(6), 381-395.

Gozgor, G., & Ongan, S. (2017). Economic Policy Uncertainty and Tourism Demand: Empirical Evidence from the USA. *International Journal of Tourism Research*, *19*(1), 99-106.

Grechi, D., Ossola, P., & Tanda, A. (2017). The European Tourism Industry in Crisis: A Stock Market Perspective. *Tourism Analysis*, *22*(2), 139-148.

Huang, T.-C., & Wang, K.-Y. (2017). Investors' Fear and Herding Behavior: Evidence from the Taiwan Stock Market. *Emerging Markets Finance and Trade*, *53*(10), 2259-2278.

Jaforullah, M. (2015). International Tourism and Economic Growth in New Zealand. *Tourism Analysis*, *20*(4), 413-418.

Kisswani, K. M., Zaitouni, M., & Moufakkir, O. (2020). An Examination of the Asymmetric Effect of Oil Prices on Tourism Receipts. *Current Issues in Tourism*, *23*(4), 500-522.

Kumar, D. (2023). European Travel and Leisure Sector and Uncertainties: A Risk Spillover Analysis. *Tourism Economics*, 29(1), 48-67.

Lintner, J. (1965). Security Prices, Risk, and Maximal Gains from Diversification. *The Journal of Finance*, *20*(4), 587-615.

Liu, B.-Y., Ji, Q., & Fan, Y. (2017). A New Time-Varying Optimal Copula Model Identifying the Dependence Across Markets. *Quantitative Finance*, *17*(3), 437-453.

Liu, L., & Zhang, T. (2015). Economic Policy Uncertainty and Stock Market Volatility. *Finance Research Letters*, *15*, 99-105.

Ozair, M. (2014). What Does the VIX Actually Measure? An Analysis of the Causation of SPX and VIX. *ACRN Journal of Finance and Risk Perspectives*, *3*(2), 83-132.

Patton, A. J. (2006). Modelling Asymmetric Exchange Rate Dependence. *International Economic Review*, *47*(2), 527-556.

Reboredo, J. C., Rivera-Castro, M. A., & Ugolini, A. (2016). Downside and Upside Risk Spillovers Between Exchange Rates and Stock Prices. *Journal of Banking & Finance*, 62, 76-96.

Rejda, G. E. (2011). *Principles of Risk Management and Insurance*. Pearson Education India.

Ross, S. A., Westerfield, R., & Jordan, B. D. (2008). *Fundamentals of Corporate Finance*. Tata McGraw-Hill Education.

Seraphin, H. (2017). Terrorism and Tourism in France: The Limitations of Dark Tourism. *Worldwide Hospitality and Tourism Themes*, 9(2), 187-195.

Shahzad, S. J. H., Hoang, T. H. V., & Bouri, E. (2022). From Pandemic to Systemic Risk: Contagion in the US Tourism Sector. *Current Issues in Tourism*, 25(1), 34-40.

Whaley, R. E. (2000). The Investor Fear Gauge. *The Journal of Portfolio Management*, 26(3), 12-17.
