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Research article

Dynamic linkages between tourism subsectors and macroeconomic shocks: A wavelet analysis

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Abstract: This study examined the dynamic relationships between tourism and leisure market indices and a set of macro-financial factors, including financial volatility, equity market performance, exchange rate dynamics, oil prices, and geopolitical risk. Using daily data from May 2010 to June 2026, wavelet analysis was employed to capture time–frequency co-movements across different investment horizons. The results revealed substantial heterogeneity across tourism and leisure market segments. Equity market performance and financial volatility emerged as the dominant factors associated with tourism and leisure market dynamics, exhibiting strong and persistent relationships across medium- and long-term horizons. Oil prices and geopolitical risk influence tourism markets primarily during periods of elevated uncertainty. Exchange rate dynamics play a limited role and exhibit weaker and less persistent effects. The findings revealed that tourism and leisure markets are closely interconnected with global macro-financial conditions and that the transmission of external shocks varies across market segments and investment horizons.

Keywords: tourism and leisure markets; macro-financial shocks; financial volatility; geopolitical risk; oil prices; wavelet analysis

JEL Codes: G15, C22, C40, F36

1. Introduction

The tourism sector plays a pivotal role in the global economy, contributing significantly to gross

domestic product, employment, and regional development (Nguyen and Nguyen, 2021). At the same time, it is one of the industries most exposed to external shocks due to its reliance on macroeconomic cycles, financial markets, and geopolitical developments (Bazargani and Kiliç, 2021; Shahzad et al., 2023). The succession of recent global shocks, including the COVID-19 pandemic, geopolitical conflicts, and energy market disruptions, has demonstrated the sensitivity of the tourism industry to macroeconomic and financial conditions. Evidence from global markets indicates that tourism firms' stock prices responded positively to COVID-19 stimulus measures, highlighting the sector's sensitivity to macroeconomic policy interventions (Elrazaz et al., 2024). For example, announcements concerning the COVID-19 pandemic generated significant negative returns for tourism equities in Japan, although part of this effect was offset by government support (Sakawa and Watanabe, 2022). Beyond policy support, financial flexibility emerged as an important determinant of resilience among tourism firms during the pandemic (Zhang et al., 2022).

Subsectoral heterogeneity in the tourism industry is substantial. Different segments of tourism and leisure activities exhibit varying responses to changes in oil prices, exchange rates, financial market conditions, and geopolitical developments. Air transport is particularly sensitive to oil price fluctuations because fuel represents a major operating cost (Mensi, 2019). Hospitality, travel, and leisure activities are also influenced by exchange rate movements, which affect international travel demand, destination competitiveness, and pricing decisions (Blengini and Heo, 2024). In addition, sector performance is shaped by investor sentiment—often captured by volatility indices–and equity market developments that reflect expectations regarding economic activity and consumer spending (Akdağ et al., 2019). Geopolitical tensions may affect tourism flows, investment decisions, and market valuations by increasing uncertainty and altering travel patterns. The combined effects of changes in energy prices, exchange rates, and financial volatility can amplify pressures across tourism markets. The differences highlight the need to view tourism as a collection of interconnected segments with distinct exposures to macro-financial and geopolitical shocks.

Research on the financial exposure of the tourism industry has expanded considerably in recent years. Much of the literature focuses on single-country cases, such as Fiji (Kumar and Patel, 2024), or adopts a regional perspective. For example, Hadi et al. (2023) examined the connectedness of U.S. tourism subsectors under financial and economic uncertainty, while Martins et al. (2023) focused on the European market, limiting evidence across different geographical contexts. Many studies also examined specific firms or defined market segments, offering limited insight into the heterogeneous responses of tourism activities to macro-financial shocks (Poretti and Heo, 2022). Research has tended to analyze crises separately, particularly COVID-19, without accounting for overlapping or persistent shocks (Chen et al., 2024). Consequently, evidence on how different tourism and leisure segments have responded to the succession of shocks observed since 2020, including the COVID-19 pandemic, energy market instability, and rising geopolitical tensions, remains limited. From a methodological perspective, static regressions and correlation analyses are frequently employed, although they provide only a partial view of the evolving relationships between tourism markets and macro-financial variables (Qin et al., 2021). Recent applications of wavelet and quantile methods provide valuable insights into volatility and uncertainty transmission (Bai et al., 2025). The literature remains fragmented and largely confined to short horizons, highlighting the need for comparative, multi-segment, and dynamic approaches capable of distinguishing between short-term fluctuations and long-term structural shifts.

This study examines how major segments of the tourism and leisure industry respond to macro-financial and geopolitical shocks across different investment horizons. The analysis is based

on a global dataset of tourism and leisure indices covering the period from May 2010 to June 2026, encompassing the pre-pandemic expansion, the COVID-19 crisis, the recovery phase, and subsequent episodes of energy market instability and geopolitical tensions. The study focuses on key segments of the tourism and leisure industry, including airlines, hospitality and leisure activities, travel and leisure services, and travel and tourism markets. In contrast, much of the existing literature examines individual firms or specific national markets. Wavelet analysis is employed to capture both time and frequency domains and to identify relationships that evolve across different horizons. In addition to oil prices, exchange rates, and financial volatility, the analysis incorporates equity market performance and geopolitical risk, allowing for a comprehensive assessment of the macro-financial forces shaping tourism markets. The study provides new evidence on the relationships between external shocks and different tourism segments and contributes to a better understanding of how the effects of macro-financial and geopolitical developments vary over time and across investment horizons.

The remainder of the paper is structured as follows: Section 2 reviews the theoretical background and related literature. Section 3 presents the data and methodology. Section 4 reports the empirical findings and robustness, followed by Section 5, which discusses their implications. The final section concludes by outlining limitations and directions for future research.

2. Literature review

2.1. Macroeconomic and financial determinants of tourism

Tourism is widely recognized as a cyclical sector, closely linked to macroeconomic conditions and financial market dynamics. Early studies emphasized its procyclical character, showing that tourism growth is shaped by global economic performance and income levels (Irani et al., 2022). Evidence from Vietnam illustrates that hotels, airlines, and tourism companies display heterogeneous market risk across different macroeconomic phases, with entertainment and tourism firms experiencing the highest fluctuations in equity beta during the post-low inflation period (Hang et al., 2020). Similar patterns are reported in cross-country analyses, which demonstrate that tourism equities are highly sensitive to macro-financial shocks and exhibit pronounced subsectoral differentiation (Shahzad et al., 2023). The influence of macroeconomic conditions extends beyond tourism demand to financial markets, where changes in volatility, investor sentiment, and economic expectations shape the performance of tourism firms and sectoral indices.

Among macroeconomic drivers, oil prices have attracted particular attention because they strongly influence operational costs. Air transport and other energy-intensive tourism activities are vulnerable to fuel price fluctuations, and studies show that rising crude oil prices reduce profitability and increase uncertainty (Muddasir et al., 2025). Research on the aviation sector also indicates that airline stock prices are highly sensitive to oil price volatility. Exposure to movements in the U.S. dollar may amplify these adverse effects (Horobet et al., 2022). Evidence from equity markets suggests that oil price shocks can spread across industries, although the impact varies with energy dependence and firms' ability to manage risk (Arouri et al., 2012).

Financial market indicators such as the S&P 500 (SPX) and the CBOE Volatility Index (VIX) are frequently employed to capture macro-financial influences on tourism. The SPX reflects overall equity market performance and serves as an indicator of investor confidence (Lee et al., 2002). The VIX

captures market expectations regarding risk and volatility and is widely used as a measure of financial uncertainty. Empirical evidence shows that increases in market uncertainty place pressure on tourism firms by reducing discretionary spending and raising financing costs, a pattern also observed in other cyclical industries (Kumar and Bouri, 2024).

This body of literature shows a strong connection between tourism and macro-financial conditions. Oil prices, exchange rates, and financial market indicators consistently emerge as key determinants of sectoral outcomes, although the magnitude of these effects varies across activities. Segments with high transportation and energy costs tend to be more exposed to fluctuations in oil markets. Hospitality, travel, and leisure activities, by contrast, are often more sensitive to exchange rate movements and changes in consumer demand (Reivan-Ortiz et al., 2023). Understanding these differences is essential for assessing how macroeconomic conditions affect the tourism industry.

2.2. Uncertainty, crises, and geopolitical risk

Tourism has proven highly vulnerable to uncertainty and crisis events, with both domestic and global shocks shaping sector performance. Evidence from European markets indicates that tourism stock returns are strongly influenced by market sentiment and financial uncertainty, particularly during periods of economic and financial distress (Grechi et al., 2017). The COVID-19 pandemic exposed such vulnerabilities, generating substantial volatility across tourism equities. Zeng et al. (2024) distinguished between the initial impact of the pandemic on stock market volatility and the subsequent time to recovery. Airlines, hotel companies, and cruise operators experienced persistent instability, with asymmetric GARCH models revealing heightened uncertainty and reduced forecasting accuracy during the crisis (Caiado and Lúcio, 2023).

Major crises highlight the vulnerability of the tourism sector. The global financial crisis of 2008, the COVID-19 pandemic, and recent geopolitical disruptions demonstrate that the relationships between macroeconomic variables and tourism change during periods of economic and financial stress (Wang et al., 2022). The pandemic increased volatility across the travel and leisure industry and led to structural changes compared with earlier periods (Sevil et al., 2025). Evidence from emerging markets indicates that political instability and health crises increase volatility in tourism firms. Investor sentiment and economic policy uncertainty also contribute to market pressures (Ullah et al., 2024).

Geopolitical risk has become an increasingly important determinant of tourism performance. Evidence from BRICS economies indicates that geopolitical tensions and currency volatility exert negative short-term effects on tourist arrivals (Reivan-Ortiz et al., 2023). Studies focusing on European countries on the European travel and leisure sector during the Russo–Ukrainian conflict highlight the influence of financial variables, energy price instability, and geopolitical pressures. Studies focusing on European Union (EU) countries show that both economic policy uncertainty and investor sentiment are significant predictors of travel and leisure stock returns, with heterogeneous impacts across the United Kingdom (UK), Germany, Spain, and France (Al Hadood and Irani, 2021). Ersan et al. (2019) demonstrated that global and European economic policy uncertainty negatively affect the STOXX Europe 600 Travel & Leisure Index (SXTP), with economic policy uncertainty (EPU) measures offering stronger predictive power for tourism equities than conventional macroeconomic indicators.

The literature demonstrates that uncertainty, whether financial, political, or geopolitical, intensifies the vulnerability of tourism markets. Short-term crises often generate sharp volatility spikes and abrupt market adjustments. Persistent risks may erode valuations and restrict investment, reflecting

the structural fragility of the industry in the face of global shocks (Soni et al., 2023). The dynamic nature of the relationships highlights the importance of methodological approaches capable of capturing interactions between tourism markets and macro-financial factors across different time horizons and frequencies (Lee and Choi, 2023).

2.3. Emerging perspectives in tourism finance and resilience

In addition to macroeconomic and geopolitical influences, corporate characteristics may also shape the financial performance and resilience of tourism businesses. Evidence from emerging markets indicates that factors such as leverage, liquidity, and earnings affect the capacity of firms to withstand periods of economic stress. Khanna et al. (2024) analyzed publicly listed tourism firms in India and showed that lower debt ratios, stronger earnings, and larger cash buffers reduced volatility during the COVID-19 pandemic. Syriopoulos et al. (2022) emphasized the structural fragility of the cruise industry, where high leverage and substantial fixed investments amplified exposure to abrupt demand shocks. Athari and Bahreini (2023) also demonstrated that rising economic policy uncertainty reduces debt ratios among Western European tourism firms, with the strongest effects observed in segments such as hotels, travel services, and recreation.

Another emerging line of research highlights the role of sustainability and investor behavior. Lei and Zheng (2025) showed that the presence of environmentally conscious investors lowers stock price volatility in tourism firms by encouraging stronger ESG practices and disclosure, although climate risks partly offset this stabilizing effect. Chen et al. (2022) provided additional evidence for U.S. airlines, finding that firms with higher environmental, social, and governance (ESG) performance were more resilient during the pandemic, as stronger scores mitigated volatility in stock returns.

Disruptive innovations and digital transformation have also attracted increasing scholarly attention. Tavor (2024) examined Airbnb communications in the Asia-Pacific region and reported negative reactions in travel and tourism indices but positive abnormal returns in real estate. Research has also expanded to include digital finance and alternative assets. Yousaf et al. (2024) identified nonlinear and asymmetric linkages between tourism and transport tokens that become stronger during periods of market stress, suggesting potential diversification opportunities for tourism investors.

The literature indicates that the financial performance of tourism businesses is shaped not only by macroeconomic and geopolitical forces but also by corporate fundamentals, sustainability practices, and technological change. Understanding resilience and valuation requires a perspective that incorporates both traditional determinants and emerging trends in tourism and financial markets.

2.4. Research gap and hypotheses

The reviewed literature shows that tourism markets are highly sensitive to macroeconomic conditions, uncertainty, and firm characteristics. Oil prices, stock market performance, exchange rates, and financial volatility are frequently identified as important determinants of tourism and leisure market performance (Ghosh, 2022). Political, economic, and geopolitical uncertainty increases volatility and weakens market valuations. In contrast, strong financial fundamentals, sustainability practices, and technological adaptation may contribute to resilience and long-run performance.

Most studies rely on econometric approaches such as linear regressions (Shiljas et al., 2022), vector autoregression (VAR) models (Sahiner et al., 2026), or generalized autoregressive conditional

heteroskedasticity (GARCH) models (Ullah et al., 2024). Although useful, such methods are less suited to capturing relationships that change across time and investment horizons (Sevil et al., 2025). Recent studies have introduced alternative approaches, including time-varying parameter models in tourism demand (Song et al., 2025) and copula-based CoVaR methods for analyzing risk spillovers (Kumar, 2023). Much of the evidence comes from individual countries or specific tourism segments, such as airlines (Merkert and Swidan, 2019), which limits direct comparisons across markets and activities. Research also tends to examine oil prices, exchange rates, and equity markets in isolation, leaving limited evidence on how macro-financial factors interact across tourism segments and investment horizons.

This study investigates the relationships between tourism and leisure markets and key macro-financial factors using wavelet analysis and a global dataset of tourism and leisure indices. The analysis considers oil prices, exchange rates, equity market performance, financial volatility, and geopolitical risk.

Based on these considerations, three hypotheses are advanced:

H1. Oil prices and exchange rate fluctuations significantly affect tourism and leisure market indices, with effects varying across market segments.

H2. Financial volatility and equity market performance significantly influence tourism and leisure market performance.

H3. The relationships between macro-financial factors and tourism and leisure markets are dynamic and vary across investment horizons.

3. Data and methodological framework

3.1. Dataset

The empirical analysis is based on daily observations from May 2010 to June 2026. The sample period covers the pre-pandemic expansion, the COVID-19 crisis, the subsequent recovery, and recent episodes of geopolitical and energy market instability, including U.S.–China trade tensions and the energy market disruptions linked to the 2026 Iran war. The starting date of May 2010 is determined by data availability constraints, as the Dow Jones U.S. Leisure Goods Index (DJUSCG) and the Dow Jones Travel & Tourism Index (DJUSTT) have continuous observations only from that period onward.

The dataset includes five tourism and leisure market indices representing different segments of the industry (Table 1), covering airlines, hospitality, travel and leisure, consumer goods, and tourism activities through the NYSE Arca Airline Index (XAL), the S&P 500 Hotels, Restaurants & Leisure Index (TRGSPHRL), the STOXX Europe 600 Travel & Leisure Index (SXTP), the DJUSCG, and the DJUSTT.

The selection of tourism and leisure market indices was guided by the Refinitiv Business Classification (TRBC) framework. The chosen indices were matched as closely as possible to major tourism and leisure activities identified within the TRBC structure. Given the limited availability of sector market indices for certain tourism activities, travel, leisure, and tourism indices were used to provide representative coverage of the industry.

Although air transportation is classified within the transportation sector under the TRBC framework, it was included in the analysis because of its fundamental role in supporting tourism activity. Air travel constitutes a key component of the tourism value chain, directly influencing tourist mobility, destination accessibility, and tourism demand. Previous studies have analyzed airlines together with other tourism and leisure activities, reflecting strong economic linkages and

common exposure to macroeconomic shocks, energy price fluctuations, and shifts in travel demand (Mensi, 2019; Shahzad et al., 2023).

To capture external macro-financial influences, the analysis incorporates four variables widely used in the literature: the VIX as a measure of financial uncertainty, the SPX as a proxy for equity market performance and investor sentiment, the U.S. Dollar Index (DXY) as an indicator of exchange rate dynamics, and West Texas Intermediate crude oil prices (WTI) as a benchmark for energy market conditions. Geopolitical risk (GPR) is included as an additional measure of geopolitical uncertainty in the robustness analysis.

Table 1. Tourism subsectors and macroeconomic variables.

Sector/variable	Index	Code	Region
Airlines	NYSE Arca Airline Index	XAL	USA
Hotels, restaurants, and leisure	S&P 500 Hotels Restaurants & Leisure	TRGSPHRL	USA
Travel and leisure	STOXX Europe 600 Travel & Leisure	SXTP	Europe
Leisure goods	Dow Jones U.S. Leisure Goods Index	DJUSCG	USA
Travel and tourism	Dow Jones Travel & Tourism	DJUSTT	Global
Online travel agencies	Dow Jones Travel & Tourism	DJUSTT	Global
Macro-financial factors	S&P 500 Index	SPX	USA
Macro-financial factors	CBOE Volatility Index	VIX	USA
Macro-financial factors	US Dollar Index	DXY	USA
Macro-financial factors	WTI Crude Oil	WTIUSD	Global
Macro-financial factors	Geopolitical Risk Index	GPRD	Global

All series were converted into logarithmic returns to facilitate comparability across variables with different scales and address potential non-stationarity (Figure 1). Data were obtained from Refinitiv, Yahoo Finance, Investing.com, and other publicly available financial databases. Descriptive statistics and unit root tests (ADF, PP, and KPSS) were conducted to assess the statistical properties of the series and verify their suitability for wavelet analysis. The corresponding results are reported in the supplementary materials.

Figure 1 reveals substantial heterogeneity across tourism and leisure market segments. All indices experienced pronounced declines during the COVID-19 outbreak in 2020, followed by distinct recovery paths. The XAL recorded the sharpest contraction and remained relatively volatile throughout the post-pandemic period. In contrast, the TRGSPHRL, DJUSCG, and DJUSTT exhibited strong recoveries, reaching levels above pre-pandemic values by the end of the sample period. The SXTP also recovered following the pandemic shock, although it followed a less consistent trajectory.

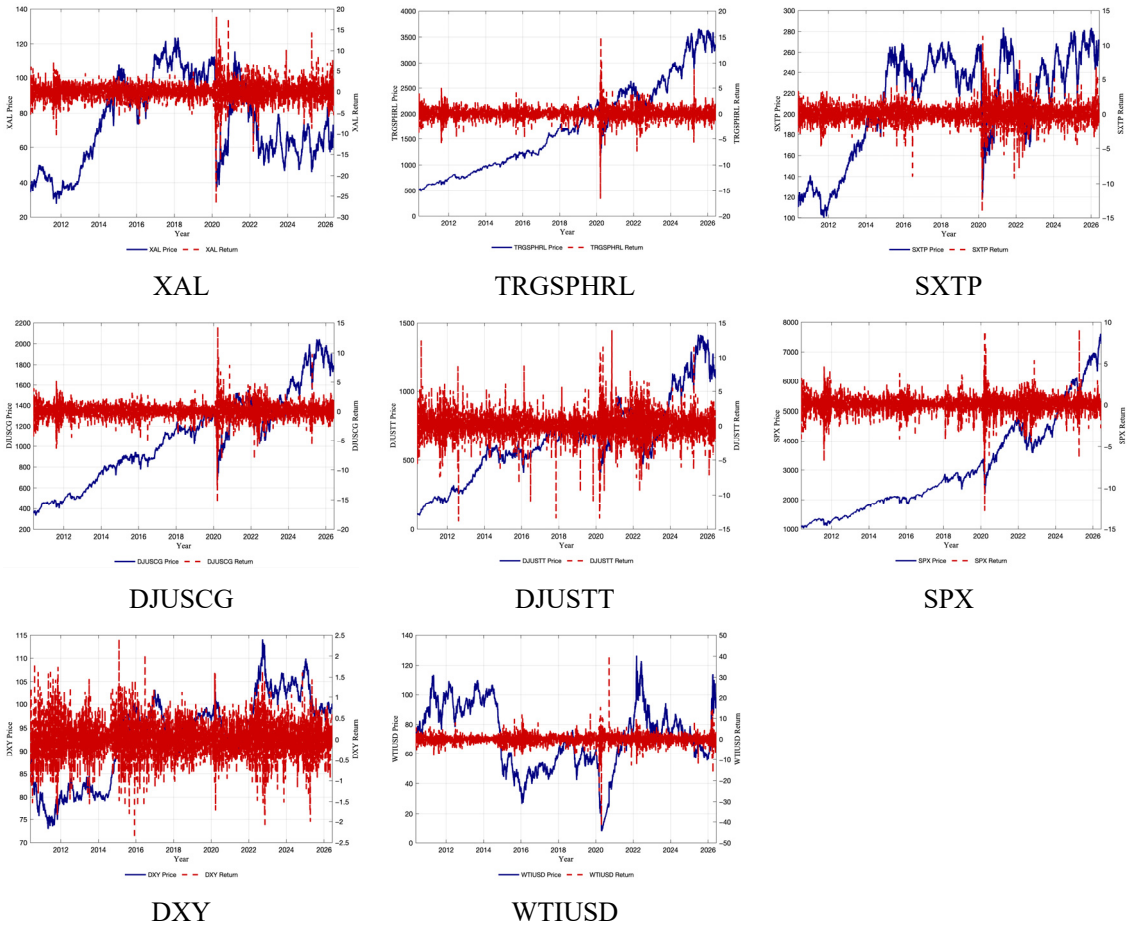


Figure 1. Prices and returns of tourism equities and macroeconomic variables. Note: The dashed red line represents returns, and the dark blue line represents prices. Sources: Authors' elaboration.

The return series exhibit the typical characteristics of financial markets, including volatility clustering and periods of heightened turbulence. The largest fluctuations occur around major disruptive events, particularly the COVID-19 crisis in 2020 and subsequent episodes of energy market instability and geopolitical uncertainty. Macro-financial variables display similar patterns. The SPX reflects the recovery of financial markets, the U.S. Dollar Index reaches elevated levels during periods of uncertainty, and WTI crude oil prices show substantial volatility, ranging from the unprecedented collapse of April 2020 to the sharp increases recorded in 2022. The magnitude of oil price movements is particularly relevant for tourism and leisure activities, especially segments with high transportation and operating costs.

3.2. Descriptive statistics and unit root tests

Descriptive statistics for the return series of tourism and leisure indices and macro-financial

variables reveal common characteristics of financial data, including near-zero mean returns, pronounced volatility, negative skewness, excess kurtosis, and the rejection of normality. Such features support the application of time–frequency methods such as wavelet analysis. Stationarity was assessed using the ADF, PP, and KPSS tests, which confirm the suitability of the return series for the subsequent analysis. Detailed results are reported in the supplementary materials (Tables S1–S2).

3.3. Methodology

To investigate the dynamic interactions between tourism and leisure markets and macro-financial factors, this study applies wavelet analysis, a methodology particularly suitable for non-stationary and volatile financial time series. In contrast to classical time-domain or frequency-domain techniques, wavelets provide a joint time–frequency decomposition that reveals the strength of relationships across different investment horizons. Recent applications in tourism research demonstrate the ability of wavelet methods to capture heterogeneous responses to economic, financial, and geopolitical uncertainty, highlighting their usefulness in analyzing shocks and resilience in tourism markets (Ngoc et al. 2024, Wu et al. 2025).

Formally, the continuous wavelet transform (CWT) of a time series $x(t)$ with respect to a mother wavelet $\psi(t)$ is defined as (Torrence & Compo, 1998):

$$W_x(u,s) = \frac{1}{\sqrt{u}} \int_{-\infty}^{\infty} x(t)\, \Psi^* \left(\frac{t-s}{u} \right) dt, \tag{1}$$

where u denotes the position in time, s is the scale parameter inversely related to frequency, and $\psi^*(\cdot)$ represents the complex conjugate of the mother wavelet. In this study, the Morlet wavelet is employed due to its balance between time and frequency localization (Torrence & Compo, 1998). The CWT enables the decomposition of each series into time–frequency space, allowing the identification of localized cycles, volatility clusters, and structural breaks.

The dynamic co-movement between $x(t)$ and $y(t)$ is assessed using wavelet coherence (WTC). The squared wavelet coherence coefficient is expressed as:

$$R^2_{xy}(u,s) = \frac{\left| S\left(s^{-1} W_{xy}(u,s) \right) \right|^2}{S(s^{-1}|W_x(u,s)|^2)\, S\left(s^{-1} \left| W_y(u,s) \right|^2 \right)}, \tag{2}$$

where $W_{xy}(u,s) = W_x(u,s) W_y^*(u,s)$ is the cross-wavelet transform, and $S(\cdot)$ denotes a smoothing operator in both time and scale. The coefficient $R^2_{xy}(u,s)$ ranges from 0 (no co-movement) to 1 (perfect co-movement), with higher values indicating stronger associations (Rua, 2010). Graphical representations of WTC highlight zones of significant co-movement, typically shown in warmer colors, while phase differences are indicated by arrows. Arrows pointing right represent positive correlation (in-phase), arrows pointing left represent negative correlation (anti-phase), and diagonal arrows indicate lead–lag relationships, with the direction identifying which variable is leading.

4. Results

4.1. Continuous wavelet transform analysis

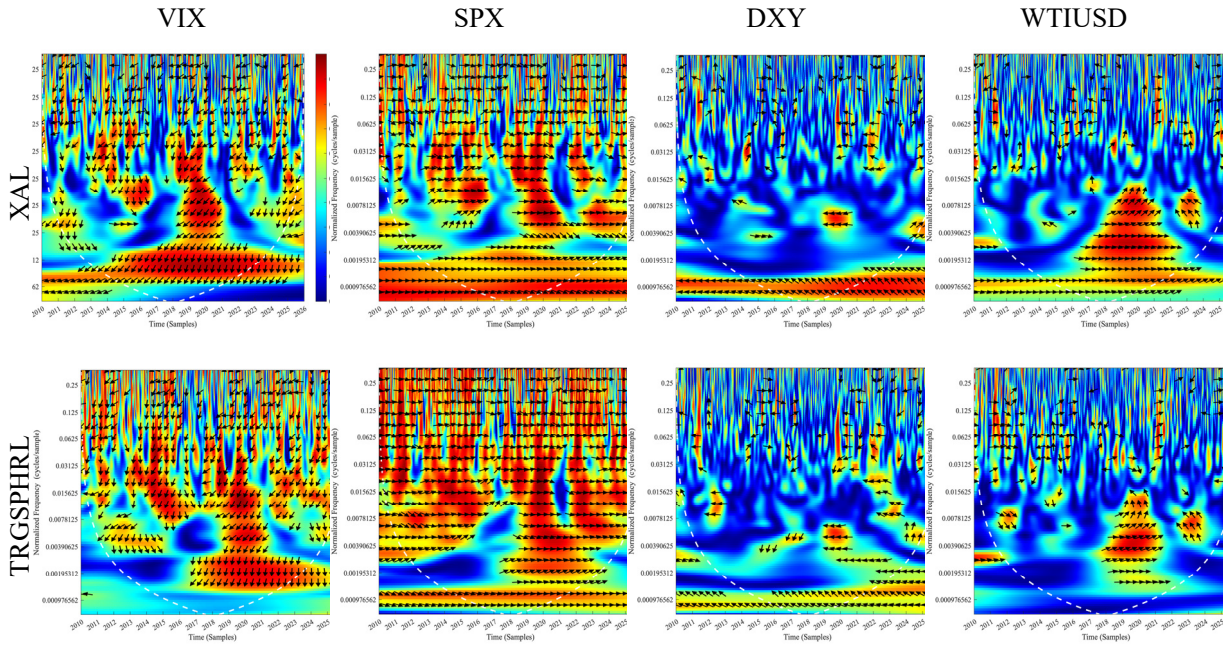
The WTC analysis presented in Figure 2 reveals substantial variation in the strength and persistence of the relationships between tourism and macro-financial factors. Across all indices, the strongest and most persistent co-movements are observed with the SPX, particularly at low and medium frequencies. Extended areas of high coherence indicate a strong relationship between equity market conditions and tourism markets over longer investment horizons.

Financial volatility also exhibits significant associations with tourism and leisure indices. Coherence is particularly pronounced during periods of elevated market uncertainty, including the COVID-19 crisis and subsequent episodes of financial turbulence. XAL and TRGSPHRL display persistent relationships with volatility dynamics, suggesting a pronounced sensitivity to changes in investor sentiment and risk perceptions.

The influence of exchange rate dynamics appears considerably weaker. Coherence between the tourism and leisure indices and the DXY is limited and concentrated in relatively short episodes. Compared with equity market performance and financial volatility, exchange rate movements appear to have a weaker association with fluctuations in tourism and leisure markets.

Oil prices display a more episodic pattern. Significant coherence is concentrated around periods of major energy market disruptions, particularly during the COVID-19 shock and the subsequent energy price surge. The strongest relationships are observed for the airline index and several tourism indices, reflecting the importance of transportation and operating costs for tourism activities.

The results indicate that tourism and leisure markets are primarily influenced by equity market performance and financial volatility. The effects of exchange rates and oil prices are more time-dependent and tend to intensify during periods of economic and geopolitical stress.



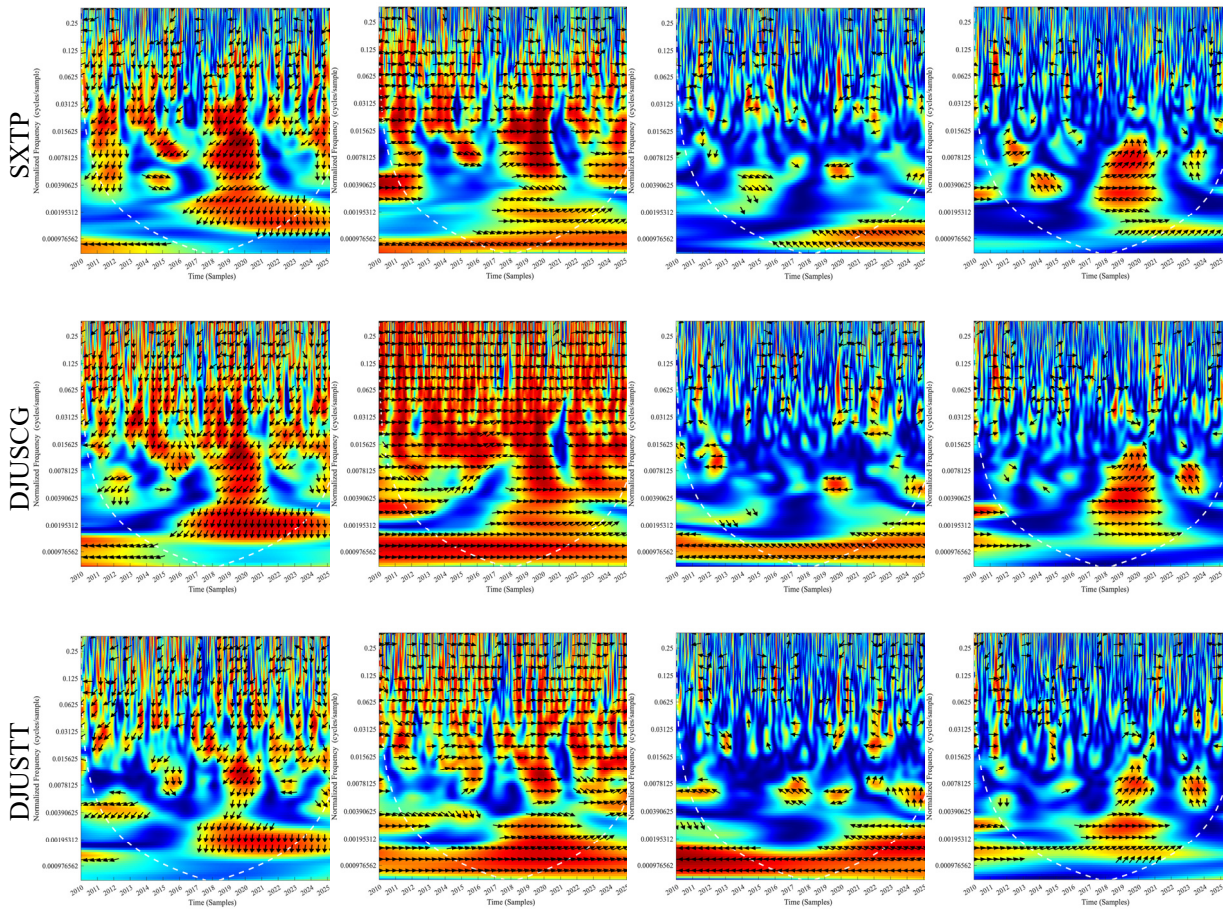


Figure 2. WTC between tourism and leisure market indices and selected macro-financial variables. Note: The color scale represents the intensity of wavelet coherence, with warmer colors indicating stronger co-movement. The horizontal axis represents time, and the vertical axis corresponds to frequency (scale). Arrows pointing right indicate positive co-movement (in-phase), arrows pointing left indicate negative co-movement (anti-phase), arrows pointing upward indicate that the tourism index leads the macro-financial variable, and arrows pointing downward indicate that the macro-financial variable leads the tourism index. The dashed curved line denotes the cone of influence. Source: Authors' elaboration.

4.2. Wavelet coherence results

The WTC analysis presented in Figure 3 reveals marked differences in the intensity and persistence of the relationships between tourism and leisure market indices and macro-financial factors. Across all indices, the strongest and most persistent coherence is observed with the SPX. Large areas of significant coherence appear across medium- and low-frequency bands, indicating a sustained relationship between equity market performance and tourism and leisure markets over longer investment horizons. This pattern is particularly evident for TRGSPHRL, DJUSCG, and DJUSTT, which display extensive periods of strong co-movement with the equity market.

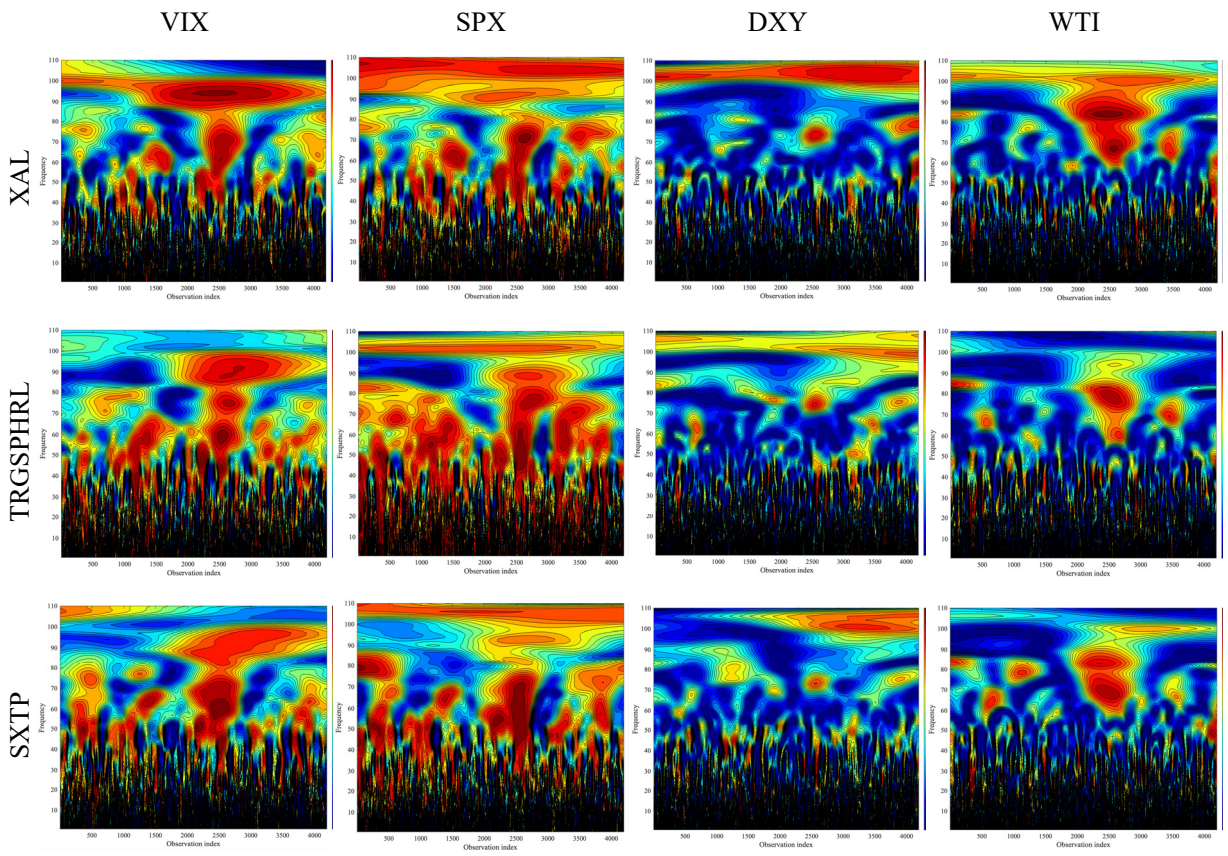
Financial volatility, measured by the VIX, also exhibits pronounced coherence with tourism and

leisure indices. Significant co-movement is observed across most of the sample period, particularly for XAL, TRGSPHRL, and DJUSCG. The intensity of the relationships increases during periods of elevated market uncertainty, suggesting that tourism market dynamics are closely associated with changes in investor sentiment and risk perceptions.

The coherence patterns associated with the DXY are generally weaker and less persistent. Significant relationships are concentrated in relatively short episodes and isolated frequency bands, indicating that exchange rate dynamics exert a more limited influence on tourism and leisure markets than equity market conditions or financial volatility.

WTI crude oil prices display a more episodic relationship with tourism and leisure indices. Significant coherence is concentrated around periods of major energy market disruptions, particularly during and after the COVID-19 crisis. The strongest associations are observed for XAL and, to a lesser extent, the travel and leisure indices, which may reflect the importance of transportation and operating costs for tourism activities.

The WTC results indicate that tourism and leisure markets exhibit the strongest relationships with equity market performance and financial volatility. Relationships with exchange rate movements and oil prices are more time-dependent and concentrated around specific episodes of economic and geopolitical stress.



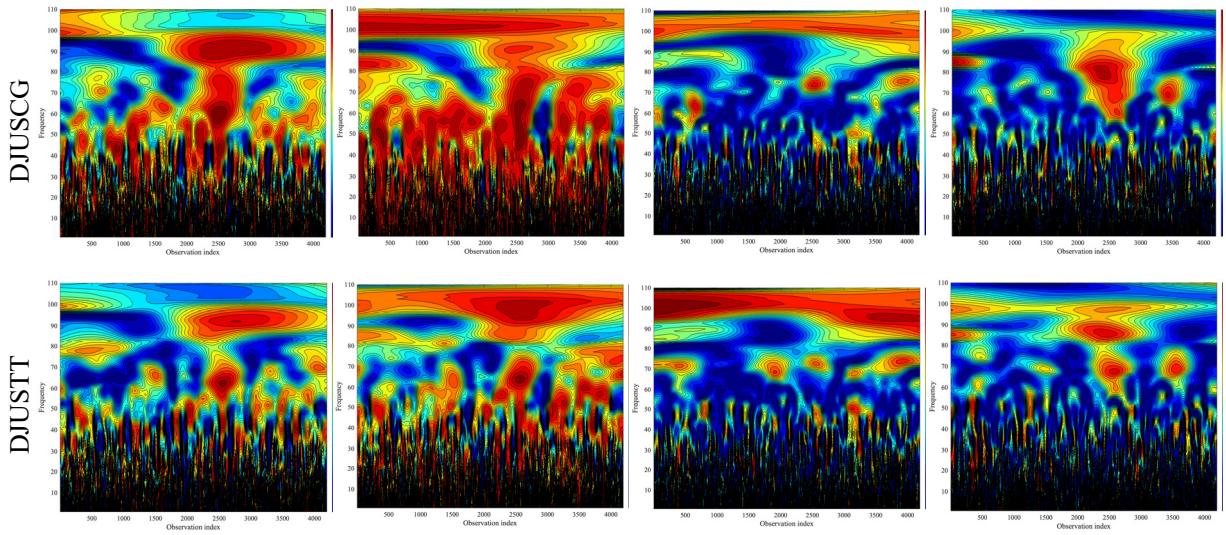
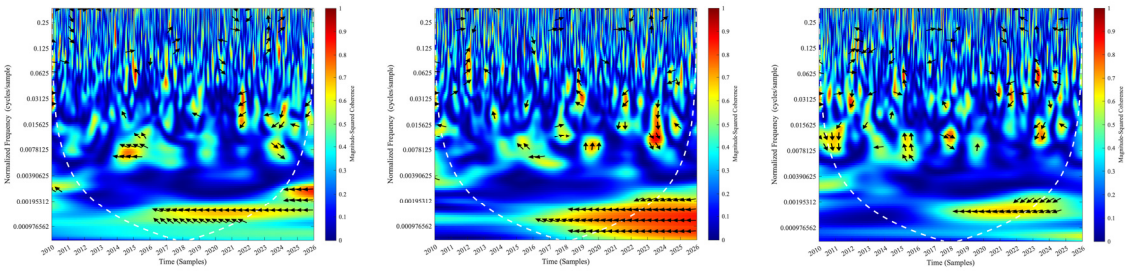


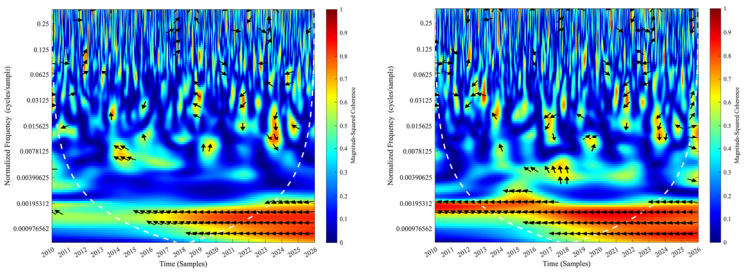
Figure 3. WTC between tourism and leisure market indices and selected macro-financial variables. Note: The color scale represents the variance distribution across time and frequency, with warmer colors indicating higher power. The vertical axis corresponds to frequency (scale), the horizontal axis to time. Source: Authors' elaboration.

4.3. Robustness analysis using the GPR index

The robustness analysis incorporates the GPR into the baseline framework. The WTC results presented in Figure 4 show that geopolitical risk is associated with recurring episodes of stronger activity across all tourism and leisure indices, particularly over longer horizons. The most visible responses coincide with periods of global tension and uncertainty, indicating that geopolitical developments are associated with movements in tourism and leisure markets. The relationship with geopolitical risk appears less pronounced than those observed for the macro-financial variables considered in the baseline analysis.



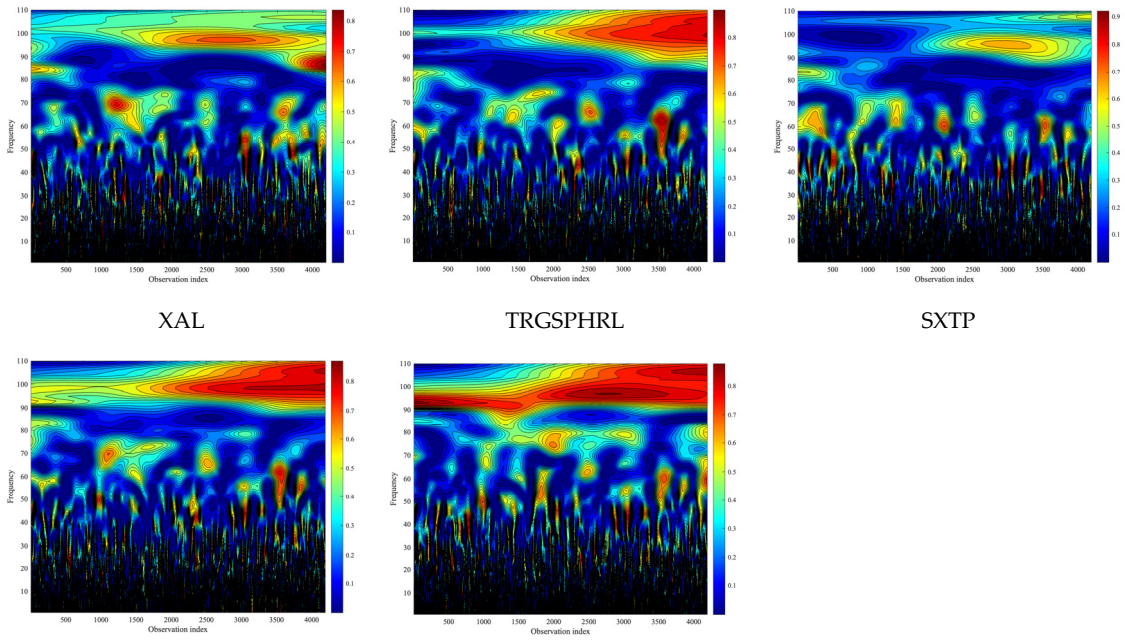
XAL TRGSPHRL SXTP



DJUSCG DJUSTT

Figure 4. WTC between tourism and leisure market indices and GPR.

Figure 5 highlights the relationship between geopolitical risk and tourism and leisure markets. Coherence appears across all indices, although its strength and persistence differ across time and frequency bands. The relationship is more persistent for DJUSCG and DJUSTT, while XAL and SXTP display shorter and less regular periods of coherence.



XAL TRGSPHRL SXTP

DJUSCG DJUSTT

Figure 5. CWT between tourism and leisure market indices and GPR index.

5. Discussion

5.1. Oil, exchange rates, and energy dependence

Oil prices and exchange rate dynamics are associated with fluctuations in tourism and leisure

markets, although the relationships are less persistent than those observed for equity market performance and financial volatility. Lee et al. (2021) documented the role of exchange rate fluctuations in China during the early phase of the pandemic. Our findings suggest that relationships with exchange rate movements remain visible during periods of market stress, although the relationship remains relatively limited and concentrated in specific time–frequency regions. This pattern indicates that currency movements are not strongly associated with variation in tourism and leisure markets at the global level.

The relationship with oil prices becomes stronger during periods of major energy market disruptions. Das et al. (2025) emphasized the asymmetric predictive power of oil price uncertainty, and our results indicate that the link between tourism and leisure markets and energy prices becomes more pronounced during episodes of heightened market stress. Liang et al. (2024) highlighted regional heterogeneity in the transmission of energy shocks. Consistent with this evidence, the present findings showed that the strength of the relationship with energy prices varies across tourism and leisure indices and investment horizons. Stronger co-movements are also typically observed during periods of pronounced financial volatility and geopolitical uncertainty.

Gao and Yang (2024) identified tourism as a net receiver of energy shocks. The evidence presented here suggests that the relationship with oil price fluctuations coincides with developments in financial markets, exchange rates, and investor sentiment.

5.2. Volatility, uncertainty, and financial markets

Financial volatility and equity market performance exhibit the strongest relationships with tourism and leisure market dynamics. The wavelet coherence results reveal strong and persistent relationships between tourism, the VIX, and the SPX across medium- and long-term horizons. This pattern suggests that tourism markets are sensitive to changes in investor sentiment, market expectations, and financial conditions.

The relationship with financial uncertainty extends beyond the pandemic period and reappears during subsequent episodes of economic, energy market, and geopolitical instability. This finding complements the evidence of immediate declines in Chinese tourism stocks during the COVID-19 crisis reported by Chen et al. (2024). Similar patterns emerge in the case of volatility transmission. Liu et al. (2023) identified volatility spillovers during COVID-19. Our results show that similar relationships remain visible across different types of shocks. The persistence of these relationships suggests that financial volatility is a recurring feature of tourism market dynamics and is not confined to individual crisis episodes.

Tourism and leisure indices remain closely linked to equity market performance throughout the sample period. This result is consistent with Ghosh (2022), who emphasized the sensitivity of leisure stocks to macroeconomic shocks and policy interventions. Uncertainty also plays an important role in shaping tourism outcomes, as documented by Zhao et al. (2022). Related evidence was provided by Zhang et al. (2022), who stressed the importance of resilience during periods of disruption. The evidence indicates that tourism markets remain closely associated with financial conditions across both crisis and non-crisis periods, confirming the relevance of macro-financial factors to sectoral dynamics.

5.3. Subsector heterogeneity and systemic interconnectedness

The results reveal substantial heterogeneity across tourism and leisure market segments. Evidence from Cepni et al. (2022) shows that COVID-19 uncertainty affected tourism firms differently. The present findings indicate that differences in sensitivity persist across tourism and leisure indices and extend beyond the pandemic period. Martins et al. (2023) documented abnormal returns in European tourism firms during the Russia–Ukraine conflict. Consistent with this evidence, the relationships observed during major shocks remain visible across medium- and long-term horizons.

Erer et al. (2023) reported efficiency losses in tourism stocks during periods of crisis. The present findings point to recurring episodes of vulnerability during periods of financial, energy market, and geopolitical stress. Demiralay and Kilincarslan (2019) emphasized the asymmetric effects of geopolitical shocks across regions. The intensity and persistence of macro-financial linkages also differ across tourism and leisure indices. Daglis and Katsikogianni (2022) documented contagion effects during the COVID-19 crisis. Wavelet coherence results show that tourism and leisure markets remain closely connected to financial conditions across multiple frequencies and investment horizons. This interconnectedness is not confined to isolated crisis events.

The evidence supports the proposed hypotheses and confirms the relevance of macro-financial conditions for tourism and leisure market dynamics. Equity market performance and financial volatility exhibit the strongest and most persistent relationships with tourism and leisure indices. Relationships with oil prices, exchange rates, and geopolitical risk become more apparent during periods of uncertainty and are less persistent over time. Differences across tourism and leisure indices also show the relevance of considering both time and frequency dimensions when assessing vulnerability and resilience.

6. Conclusions

This study examined the vulnerability of tourism and leisure market segments to macro-financial and geopolitical shocks between 2010 and 2026 using a wavelet framework that captures time–frequency dynamics. The findings demonstrate that although all tourism and leisure indices are exposed to external shocks, the relationships differ in both intensity and persistence across segments and investment horizons. Equity market performance and financial volatility exhibit the strongest and most persistent relationships with tourism and leisure markets. Relationships with oil prices, exchange rates, and geopolitical risk are more concentrated around periods of uncertainty and less persistent over time.

The findings extend previous research by showing that the negative impacts observed during events such as COVID-19 and the Russia–Ukraine conflict are part of a recurrent pattern of vulnerability. In contrast to studies limited to single crises, narrow samples, or short horizons, our analysis spans more than a decade, covers multiple tourism and leisure segments across global markets, and shows that relationships with external shocks vary across both time and frequency domains. The results indicate that tourism and leisure markets remain associated with macro-financial conditions over extended periods, with differences across shocks and investment horizons.

This study contributes to the literature in three ways. It offers a global perspective on the interaction between tourism and leisure markets and macro-financial conditions across multiple market segments and over a long sample period. It employs wavelet analysis to capture cyclical patterns of vulnerability across time and frequency dimensions. It also shows that the intensity and persistence of

macro-financial linkages differ across tourism and leisure market segments, with these differences also observed across investment horizons.

The results have important implications for both practice and policy. For investors and managers, the strong relationships between financial conditions and tourism and leisure markets support the need for risk management, investment diversification, and financial flexibility during periods of uncertainty. Changes in oil prices remain especially important for airlines and other activities with high transportation costs. For public authorities, the findings show that tourism and leisure markets can remain closely associated with financial market instability and oil price fluctuations over extended periods. Policies that support stable markets, reliable energy supplies, and business adaptation may help reduce vulnerability to future shocks.

Several limitations should be acknowledged. Although the wavelet framework is well-suited to analyzing relationships across different time horizons, it does not identify the mechanisms driving those relationships. Future studies could combine wavelet methods with structural econometric or machine learning approaches to capture nonlinear effects and improve forecasting. Research based on individual companies could also provide a more detailed assessment of how financial characteristics and business models influence vulnerability and resilience in tourism and leisure markets.

In conclusion, the evidence shows that tourism and leisure markets remain closely associated with macroeconomic, financial, and geopolitical conditions. The relationships associated with external shocks are not confined to isolated events but remain visible across multiple time horizons and differ in intensity across market segments. The findings show that patterns of vulnerability and resilience vary over time, across different shocks, and across market segments. Understanding tourism and leisure market dynamics is essential for investors, managers, and public authorities seeking to strengthen the capacity of tourism and leisure markets to withstand future disruptions.

Author contributions

Conceptualization, C.G. and O.P.; data curation, C.G. and O.P.; formal analysis, C.G. and O.P.; investigation, C.G. and O.P.; methodology, C.G. and O.P.; project administration, C.G. and O.P.; resources, C.G. and O.P.; software, C.G. and O.P.; supervision, C.G. and O.P.; validation, C.G. and O.P.; visualization, C.G. and O.P.; writing—original draft, C.G. and O.P.; writing—review and editing, C.G. and O.P.

Use of AI tools declaration

The authors declare that no Artificial Intelligence (AI) tools were used in the preparation of this manuscript.

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Conflict of interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and / or publication of this article.

Data Availability Statement

The data used in this study are publicly available from Refinitiv, Bloomberg, Yahoo Finance, and Investing.com.

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